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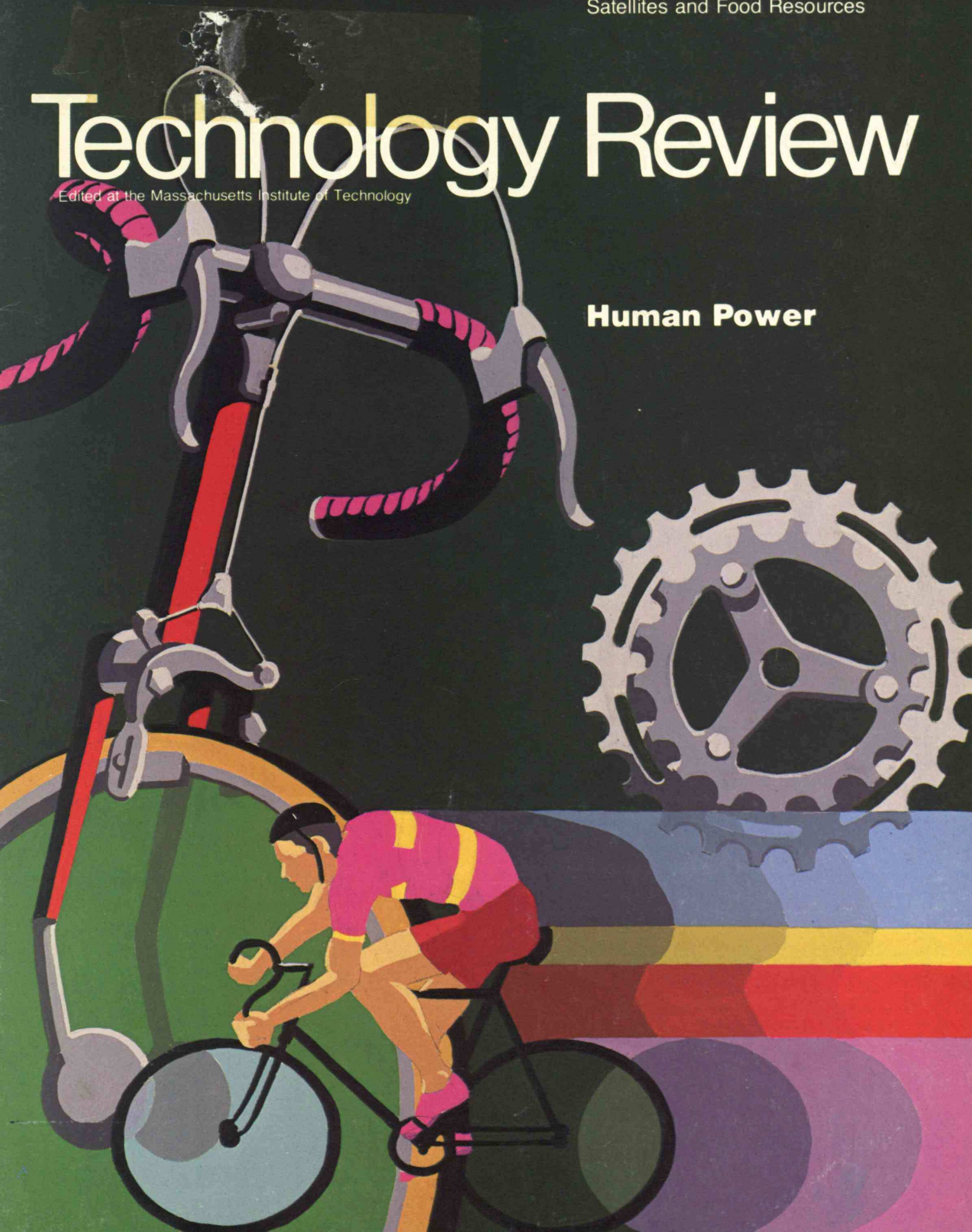
Technology Review

Edited at the Massachusetts Institute of Technology

Human Power



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To Members of the Classes of 1980 and 1981:

Now that you are entering the final stages of your undergraduate passage through M.I.T., as prospective Alumni of the Institute, it is time for you to learn more about the M.I.T. Alumni Association. It is with real pleasure, therefore, that I enroll you as a complimentary subscriber to the student edition of the Association's journal, TECHNOLOGY REVIEW, with this first issue.

An award-winning national magazine - most recently recognized by Newsweek with the Robert Sibley Award as the most distinguished alumni magazine of the year - TECHNOLOGY REVIEW is published eight times each year by the Association for both alumni and non-alumni subscribers. With a circulation of 65,000, it is received by some 35,000 M.I.T. Alumni and 30,000 paying subscribers. The student edition will be sent to you without charge five times during the current academic year.

The REVIEW has a twofold assignment: to provide for all its subscribers a sense of current issues and developments in technology and related fields, and to provide for alumni continuing contact with the Institute and among themselves. In particular, you will note the insert section of the magazine which contains news of M.I.T., as well as the highly regarded Class Notes Section which alumni use to tell each other of their doings.

Nearly 70,000 former students of M.I.T. are carried on the rolls of the Association. When you graduate from M.I.T. the Association will be the means for your continuing involvement with the Institute and contact with your classmates. Through the Association, M.I.T. Alumni are active in M.I.T. Clubs throughout the world (over 100), as workers for the Annual Alumni Fund and as educational counselors interviewing prospective M.I.T. students. We also serve on numerous committees, trusts and boards in support of the Institute and of our fellow alumni. We participate in Technology Day, Summer Colleges, conferences and special events both on and off the campus. We hope that as a student you will join us in some of these activities.

(Continued On Following Page)

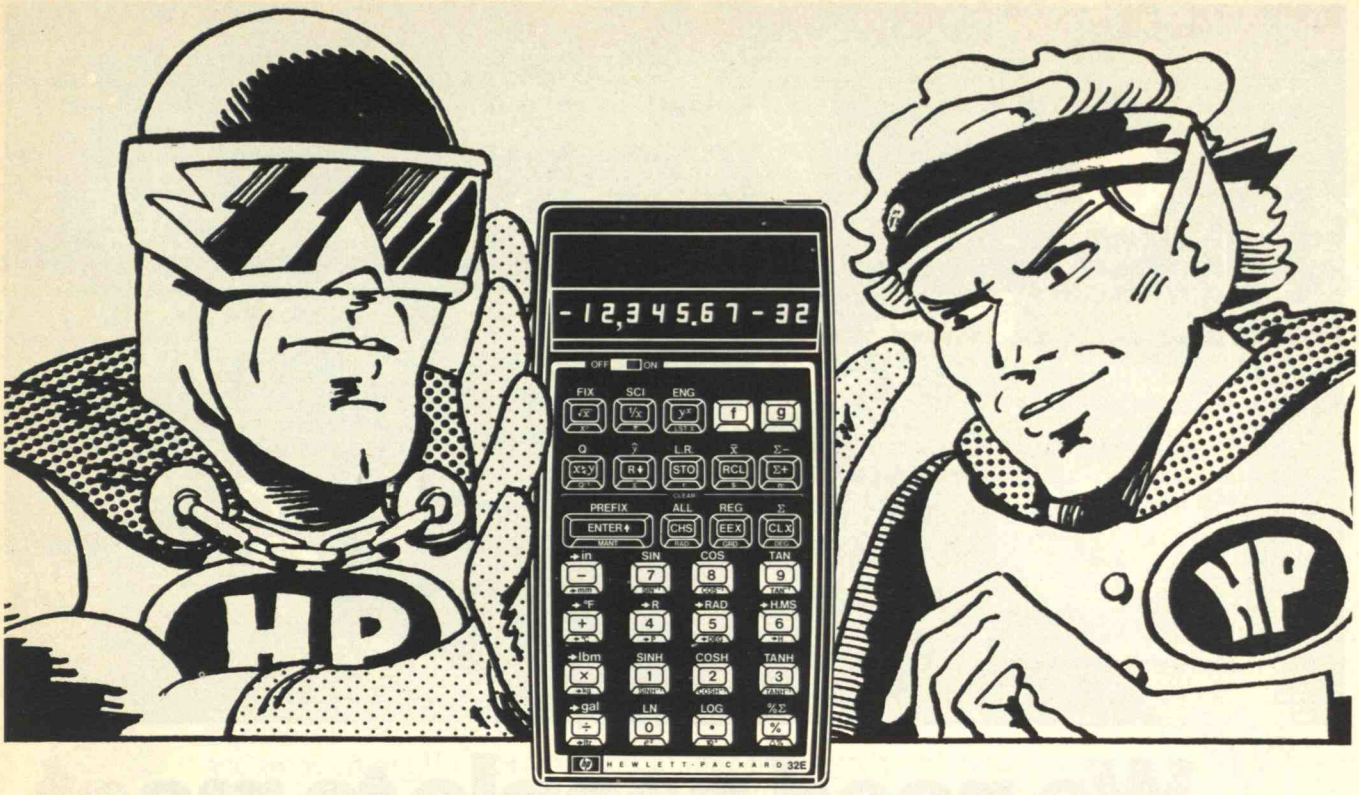
Alumni enjoy meeting students, not only as a way of keeping in touch with M.I.T., but also because we are sincerely interested in our students' well-being and their attitudes towards M.I.T. and their professions. During the year you may receive invitations to visit with alumni to share your experiences at M.I.T. and talk of involvement with the Institute after graduation. We hope that you will accept these invitations.

The Association maintains its headquarters in the Alumni Center on the first floor of the McLauren Building, Building 10. An office and a smaller staff is also located in New York City. Our staff, particularly those here in Cambridge, welcome the opportunity of working with you on student projects. Please drop in at the Alumni Center if you wish to learn more about the Association or if you want to join in alumni activities.

I trust that TECHNOLOGY REVIEW will serve you well and that it will be an inducement to you to sustain your ties to M.I.T. after graduation. I also look forward to meeting you personally on one of the many occasions when alumni and students get together during this academic year.

Very truly yours,

Claude W. Brenner '47
President



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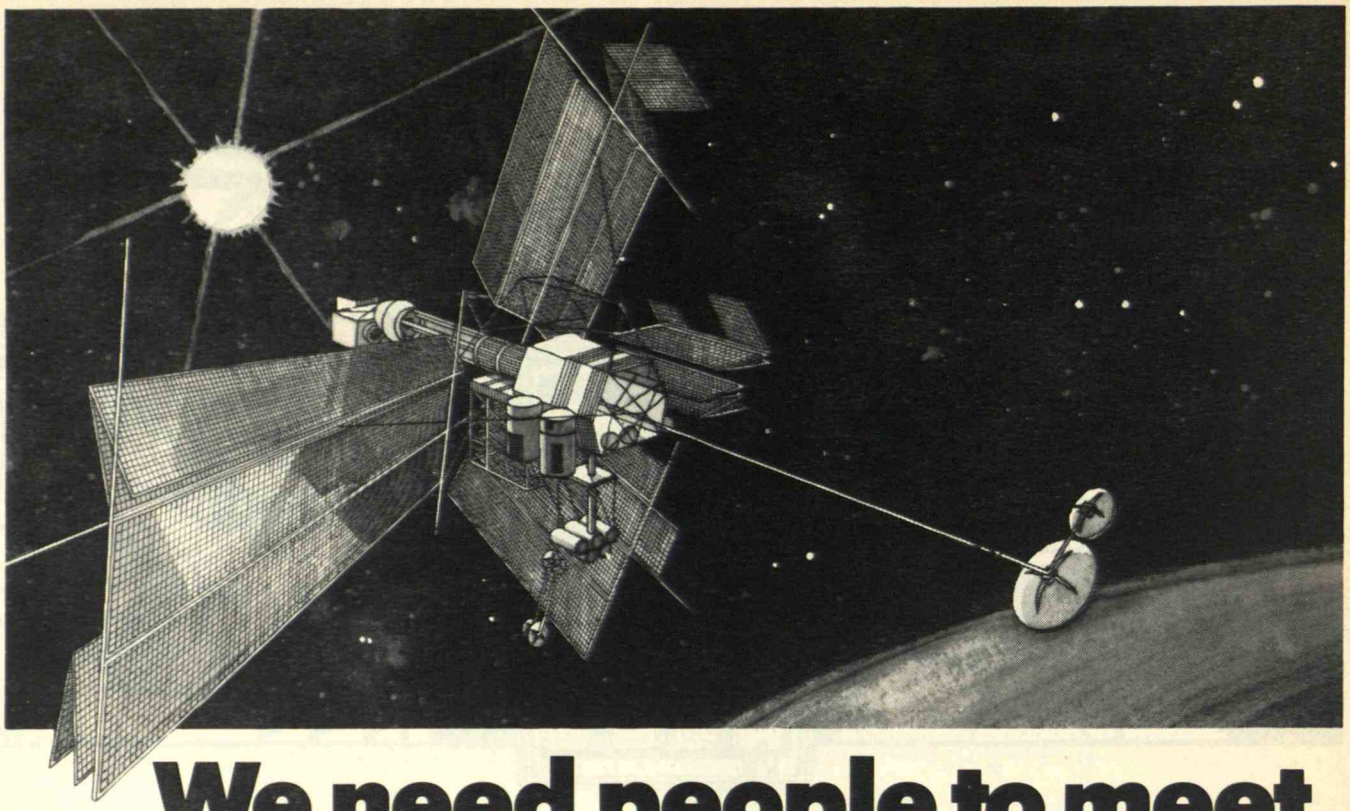

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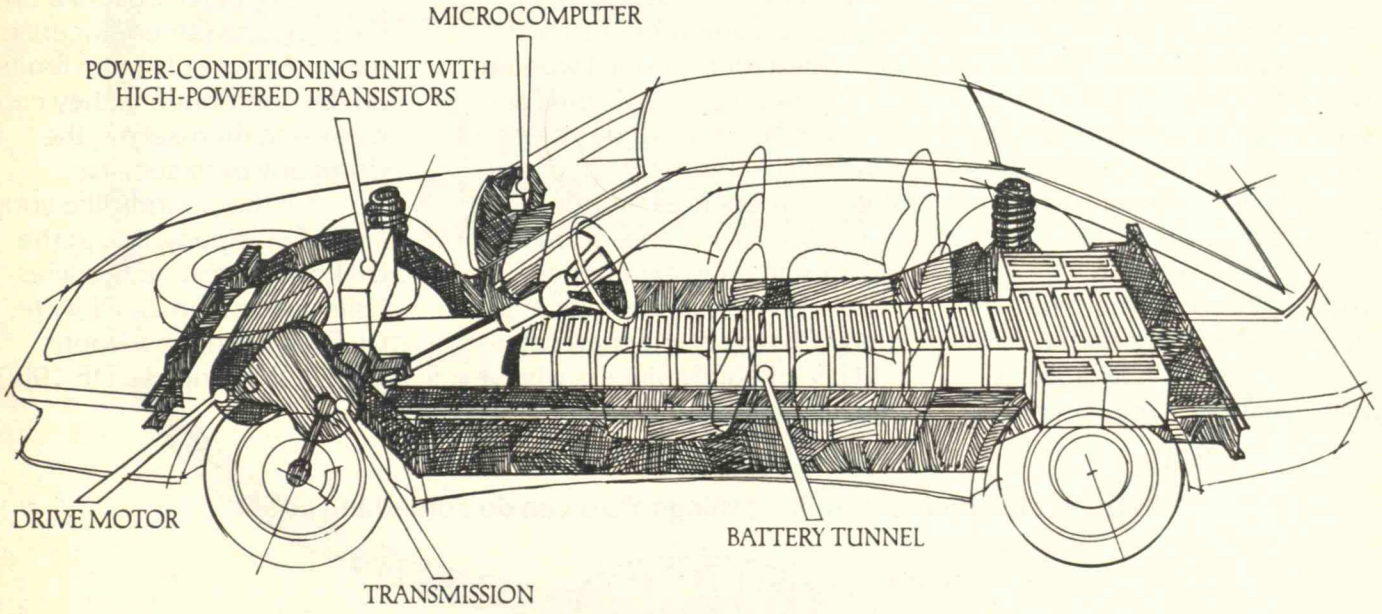

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—David A. Dindinger BS, Chemical Engineering

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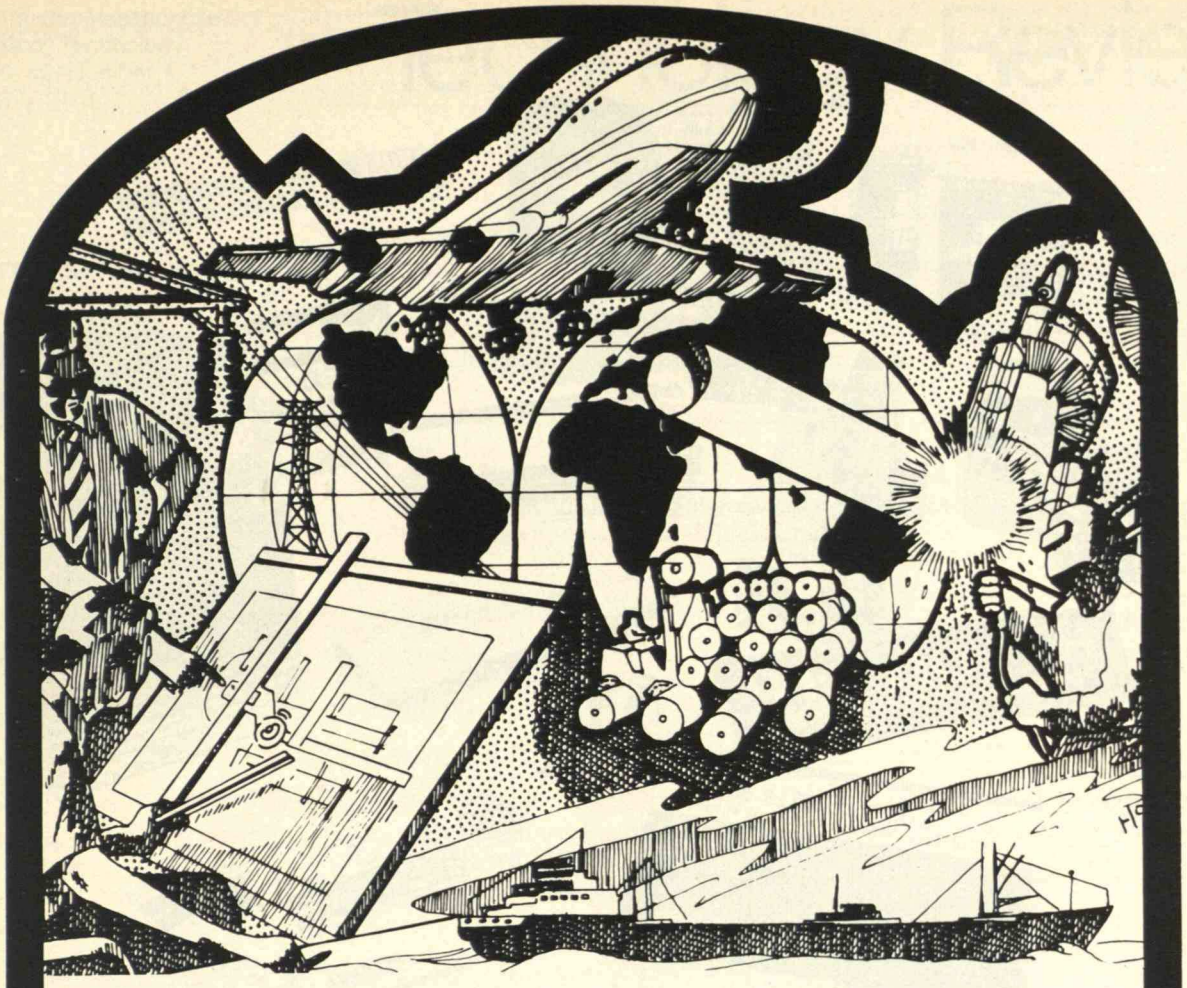

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October, 1979

Technology Review

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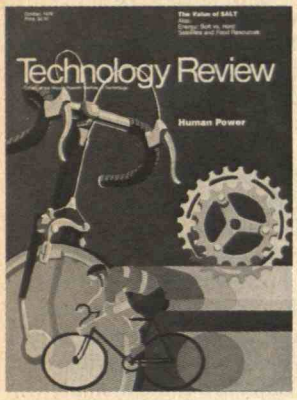

Human-Powered Transportation, page 42

Cover Painting by Oren Sherman

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COLUMNS

DEPARTMENTS

Technology Review

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Human Power

David Gordon Wilson's article on human-powered transportation (*page 42-54*) had many advocates on our Board of Editors, but none was more convincing than Leonard A. Phillips (*below*).

After a survey of the community's various responses to the summer's gasoline shortage, *Tech Talk*, M.I.T.'s "house organ," concluded that Mr. Phillips is "one of the most heroic energy-savers at the Institute." Ever since May, weather permitting, he's bicycled daily to Cambridge and back to his home in Acton, Mass. — a total distance of some 50 miles.

To maintain his strength along the way, Mr. Phillips munches raisins and sips water from a bottle attached to the bicycle. He carries his working clothes neatly rolled in bags on the handlebar and seat. His best time to date for a one-way trip is one hour and 18 minutes, he says, but "I'm still improving." — *J.M.*

Volume 81

The last issue of Technology Review completed Volume 81. An index is in preparation and will be available by about the end of the calendar year at $2.50 per copy. We're accepting orders now for later delivery.

Subjective Persuasions

I became thoroughly caught up in Vince Taylor's well-written and highly subjective letter to a student on "Subjectivity and Science" (*February, pp. 48-56*). But when I reached the section on the costs of uncertainty, in which Dr. Taylor discredits time-discounted cost-benefit analysis, I came out of my trance.

Dr. Taylor argues for combining one's professional and personal life. I do not think the anonymous student would disagree. Taylor, however, seems to believe that doing so forces one to be subjective. Why can't one *try* to be objective at all times? Dr. Taylor seems to be saying that in trying to be objective professionally (as his scientific training demanded), he had difficulty quantifying his personal biases (which we all have) and so he gave up trying to be objective.

I see no real difference in the student's apparently emotional response to Dr. Taylor's work on uranium and plutonium and Dr. Taylor's response. But the student and the earlier Taylor ("at least try to be objective") seem to me the more logical approach to analyzing problems.
Frank M. Richmond
Pittsburgh, Penn.

Another Voice for Objectivity

Vince Taylor's (*February, 1979*) letter reads more like a Billy Graham revival hour than a scientific communication.

With regard to Taylor's specific proposals for policy analysis, I have some problems with his approach. Are we to become dependent on subjective analysis to solve the world's problems? Whose analysis do we use? Are we to rely on a guru-type head analyst who selects among alternative solutions by divine guidance? Do we flip a coin? Taylor further confuses the issue by renaming his subjective approach, wisdom. Unfortunately, it all boils down to the assumption that whoever is the chief magician in the King's court will have the "wisdom" to choose the best answer. I perceive this solution as a step backward for our society. It seems to me that true thought and understanding can only be clouded by Taylor's approach.
Bradley S. Albom
Berkely, Calif.

Dr. Taylor responds:

Mr. Albom and Mr. Richmond, like the

(Continued on p. 4)

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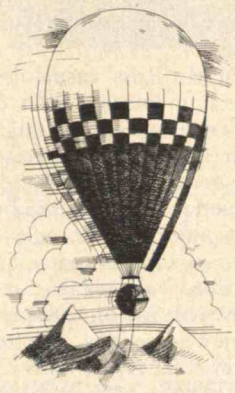

The five Rolex Awards for Enterprise, in the sum of 50,000 Swiss francs each, are conferred to provide financial help for projects which seek to break new ground in their particular sphere, and which capture the spirit of enterprise shown by Rolex and Rolex owners.

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Entries must then be submitted in English on the Official Application Form and reach the Secretariat before April 30th, 1980.

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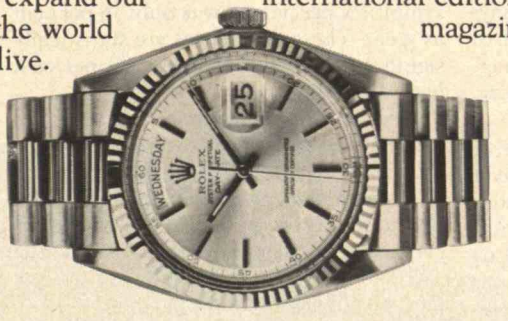

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ROLEX

(Continued from p. 2)

student to whom my letter was originally addressed, seem to have taken great comfort in labeling me "subjective" and then apply the standard arguments against subjectivity, thereby disposing of any necessity to consider further my contentions about the limitations of highly qualified analysis of complex policy issues.

I do *not* argue for the superiority of subjective over objective research, but rather for explicitly recognizing that our "objective" world is inescapably shaped and colored by our beliefs, ways of thinking, and emotions — that is, by our "subjective" world. Nor do I argue for rejecting the scientific method, but rather for recognizing what should be obvious: that applying this method only within the confines of highly quantitative, abstract models will lead to badly erroneous policy prescriptions *because* reality is far too complex to be accurately captured by such models. This is not idle conjecture but a truth painfully proven: in 1962, McNamara, the paragon of "hard" analysts, offered his "objective" evaluation of U.S. prospects in Vietnam, "Every quantitative measurement we have shows we are winning this war."

If, as seems likely, the world's most pressing problems stem not from insufficient *quantities* but from an imbalance of *qualities*, analytical science, by its very nature, will be able to make only a limited contribution to their solution. To acknowledge this limitation is neither to reject the value of logic and evidence nor to argue for replacing science with subjectivity. It does, however, imply the need to move beyond our current exclusive focus on quantitative analysis.

The sense of what I'm recommending was well conveyed by James Agee in explaining the reason for his approach ("to speak carefully and as near truly as I am able") to reporting the daily lives of white tenant farmers in the Deep South in 1939 (*Let Us Now Praise Famous Men*): "For in the immediate world, everything is to be discerned for him who can discern it, and centrally and simply, without either dissection into science, or digestion into art, but with the whole of consciousness, seeking to perceive it as it stands: so that the aspect of a street in sunlight can roar in the heart of itself as a symphony, perhaps as no symphony can: and all of consciousness is shifted from the imagined, the revisive, to the effort to perceive, simply the cruel radiance of what is."

Is such an approach more subjective than that of the quantitative policy analyst who believes equations and variables adequately describe a complex, constantly changing process and who, on the basis of his "expert" judgment, chooses values for the many empirically unknown parameters that inhabit all real world problems? Is the intelligence, honesty, and integrity of the quantitative researcher any less crucial to the result than that of the qualitative researcher? Would solutions suggested by the latter be any less susceptible to logical and empirical testing than those of the quantitative analyst? I think not.

Megadose of Misinformation

The article "The Megamyth of Megavitamins," by David M. Ross (*February, p. 84*) contains a large number of false statements.

I will not response to criticism of orthomolecular psychiatry in detail, but instead refer interested readers to the book *Orthomolecular Psychiatry: Treatment of Schizophrenia* (edited by David Hawkins and Linus Pauling, W. H. Freeman and Co., San Francisco, 1973) and also to my paper "On the Orthomolecular Environment of the Mind: Orthomolecular Theory" (American J. Psychiatry, *131:11, November, 1974*).

But Mr. Ross' casual description of my interest in megavitamin dosing is a remarkable misrepresentation of the work of Dr. G. Ritzel, a physician with the medical service of the school district of Basel, Switzerland. In my 1976 book *Vitamin C, the Common Cold, and the Flu* (W. H. Freeman and Company, San Francisco), I described it as the first carefully controlled study with use of 1,000 milligrams of ascorbic acid per day. The study was carried out in a ski resort with 279 boys during two periods of five to seven days. The conditions were such that the incidence of colds during the short period was large enough (approximately 20 per cent) to obtain statistically significant results. The subjects were of the same age (15 to 17) and had similar nutrition during the period of study. Neither the participants nor the physicians had any knowledge about the distribution of the ascorbic-acid tablets and the placebo tablets. The subjects were examined daily for symptoms of colds and other infections. The results were based largely on subjective symptoms, partially supported by objective observations (measurement of body temperature, inspection of the respiratory organs, auscultation of the lungs, and so on). The group receiving ascorbic acid showed only 39 per cent as many days of illness per person as the group receiving the placebo, and the number of individual symptoms per person was only 36 per cent as great. These differences are statistically significant at better than the 99 per cent level of confidence.

Also, in this same book, (*p. 182*), I summarize the observations of investigators in 14 controlled studies of vitamin C in comparison with a placebo, in relation to the common cold. The average decrease of illness per subject in the ascorbic-acid subjectives relative to the placebo subjects was 35 per cent.

Mr. Ross stated that "Dr. Pauling derives his vitamin C megadose from two specious premises, Dr. Wolf suspects." I object to this characterization of my work and I surmise that if Dr. Wolf had read my books and papers carefully he would not have used this adjective.

It is said that I looked at the amount of ascorbic acid that rats produce, calculated proportional amount for humans based on weight, and arrived at a figure of 2 grams per day. In fact, I looked at many species of animals. Dr. Wolf also seems to have stated that "any amount of ascorbic acid above the body's daily need — 45 milligrams — is excreted with the urine." This statement is false. Careful studies have shown that approximately 60 per cent of ascorbic acid (above a low minimum) that enters the blood stream is excreted in the urine, but the other 40 per cent is retained in the body and converted into other useful substances.

There is also a discussion of "rebound scurvy," and of addiction to large doses of vitamin C. In fact, a large intake of vitamin C induces the formation of enzymes that serve to convert the vitamin C to other useful substances. If the large doses are stopped, these enzymes remain active for a few days, and the level of ascorbate may become abnormally low. In my book I recommend tapering off over a few days, if high doses of vitamin C are to be stopped.

I recommend to readers of *Technology Review* that they not rely upon this article.

Linus Pauling
Linus Pauling Institute of Science and Medicine
Menlo Park, Calif.

Dr. Wolf responds:

Dr. Pauling takes me to task at two removes: the lecture in question was given in January, 1978, which Mr. Ross later reported in *Technology Review*. I tried to convey to the audience my great respect for the orthomolecular theory of Dr. Pauling's. I expressed regret that few neurobiologists have as yet attempted to confirm and expand experimentally a theory of such far-reaching importance.

With regard to ascorbic acid and the common cold, we now have available the results of three very large-scale studies (*summarized by T. W. Anderson*, Nutrition Today, *January/February, 1977, p. 6*), done to repeat Dr. Ritzel's original results. All come to the same conclusion, that ascorbic acid does not cure the cold, but relieves the severity of the symptoms.

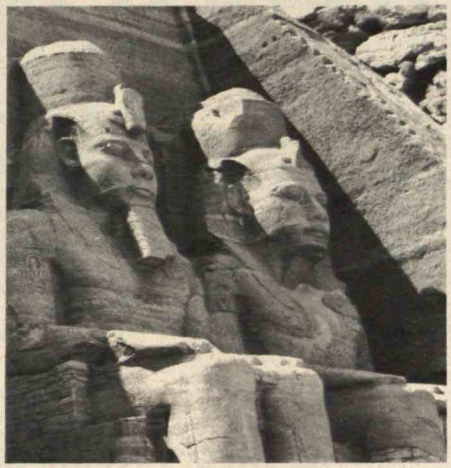
I apologize to Dr. Pauling for the use of the word "specious" (not mine), as applied to his arguments. I was aware only of research done on the rate of ascorbic acid synthesis in the rat and did not know of work on the goat and other species. As to excretion, the studies of Hodges and his group (Amer. J. Clin. Nutr., *24: 444, 1971*) showing urinary excretion of excess ascorbic acid, seem careful and satisfactory to me — I believe that no better one has been done in man.

Alumni Travel Program
1979-1980

For 1979, an expanded program of itineraries is offered, including New Guinea and a wider choice of programs in East Africa and India. Additional itineraries are also in the planning stage, including the Galapagos, southern India, the People's Republic of China and other areas.

The travel program is a special one for alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Dartmouth, Univ. of Pennsylvania and certain other distinguished universities and for members of their families. Designed for educated and intelligent travelers, it is planned for persons who might normally prefer to travel independently, visiting distant lands and regions where it is advantageous to travel as a group. The programs avoid the excessive regimentation normally associated with group travel, and are planned to include generous amounts of leisure time in the course of travel to allow for individual interests.

REALMS OF ANTIQUITY: Journeys into the past to explore the history and civilization of the ancient world. One itinerary of 17 days—***VALLEY OF THE NILE***—offers a comprehensive and authoritative survey of ancient Egypt. Starting with the British Museum and the Rosetta Stone, it visits the great monuments of ancient Egypt stretching along the Nile Valley from Memphis and Cairo to Abu Simbel near the border of the Sudan, including a cruise on the Nile from Luxor to Aswan. A second itinerary—***AEGEAN ADVENTURE***—covers the archeological treasures of classical antiquity in the lands of the Aegean in a journey of 23 days. It includes not only the historic sites of ancient Greece but also a rare view of ancient cities in Asia Minor, including the ruins of Troy, and in addition includes a cruise through the Aegean to Crete and other Aegean isles. A third itinerary—the ***MEDITERRANEAN ODYSSEY***—is a 22-day journey which follows the spread of classical antiquity into the western Mediterranean: the splendid ruins of the classical Greek cities of Sicily, the historic ruins of Carthage, ancient Roman cities in North Africa, and the fortress cities of medieval Crusaders on the rocky isle of Malta.



EAST AFRICA: A distinctive program of safaris, ranging in length from 16 to 32 days, to the great game-viewing areas of Kenya and Tanzania and to the beautiful islands of the Seychelles. Led by experts on East African wildlife, the itineraries are carefully planned and comprehensive, offering an unusually complete opportunity to see and photograph the wildlife of Africa.

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CENTRAL ASIA AND THE HIMALAYAS: A choice of 23 or 29-day itineraries exploring the vast historic and cultural heritage of India, the untamed Northwest Frontier region of Pakistan and the remote mountain kingdom of Nepal. Includes the famed Khyber Pass, imposing Moghul forts, sculptured temples, lavish palaces, formal gardens, the teeming banks of the Ganges, snow-capped peaks of the Himalayas along the roof of the world, picturesque cities and villages, the splendor of the Taj Mahal, and hotels which once were palaces of maharajas.

THE FAR EAST: Two itineraries which offer a fascinating insight into the lands and islands of the East. ***THE ORIENT,*** 29 days, is a classic tour of ancient and modern Japan, with special emphasis on the cultural treasures of Kyoto, and includes as well the important cities of Southeast Asia, from Singapore and Hong Kong to the temples and palaces of Bangkok and the island of Bali. A different and unusual perspective is offered in ***BEYOND THE JAVA SEA,*** 34 days, a journey through the tropics of the Far East from Manila and the island fortress of Corregidor to headhunter villages in the jungle of Borneo, the ancient civilizations of Ceylon, Batak tribal villages in Sumatra, the tropical island of Penang, and ancient temples in Java and Bali.

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Prices range from $2,215 to $4,175 from U.S. points of departure. Air travel is on regularly scheduled flights of major airlines, utilizing reduced fares which save as much as $600.00 and more over normal fares. Fully descriptive brochures are available, setting forth the itineraries in detail and listing departure dates, hotels, tour rates, and other information. For full details contact:

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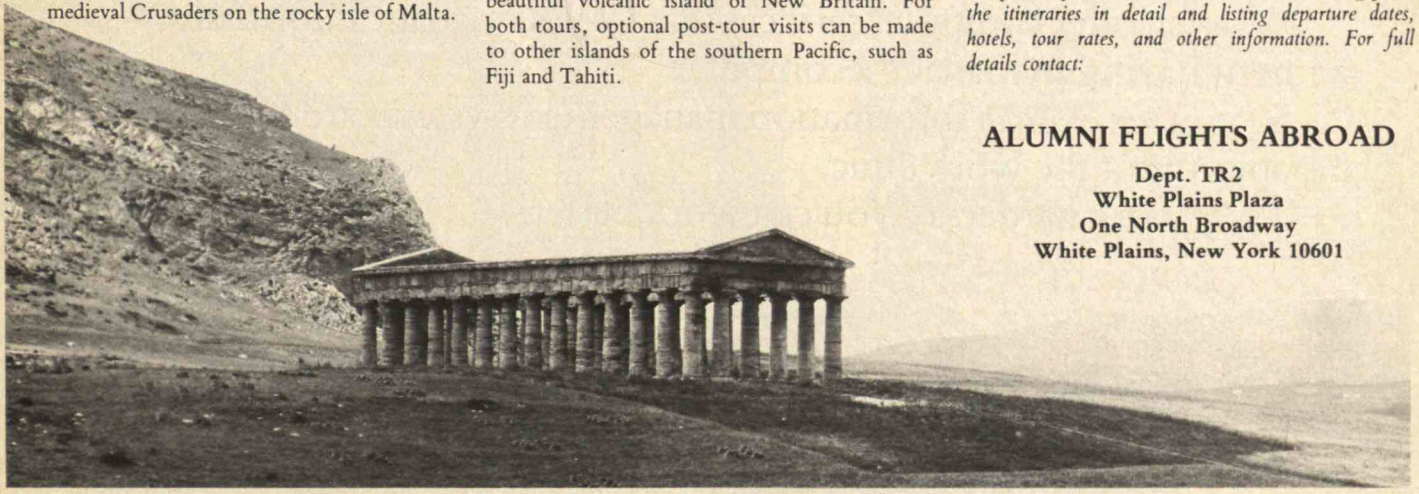

INFORMATION MANAGEMENT. DOES IT THREATEN THE WORK ETHIC?

The American work ethic has always assumed that if you worked hard, your efforts would be rewarded.

We wouldn't argue with that. But we would like to amend it a little.

The way we see it, working hard isn't nearly as important as working well.

Information Management isn't a way of sidestepping hard work. It's a way of making it more productive.

For example, there's no virtue in having to spend hours typing, retyping and re-retyping documents. So we make electronic typing systems that let you type, revise and retrieve information in a lot less time. Which gives you a lot more time to create and perfect it.

To make information easier to work with, we make a full range of copiers, duplicators and computer printers. Ones that not only reproduce, but can reduce, collate or even print in color.

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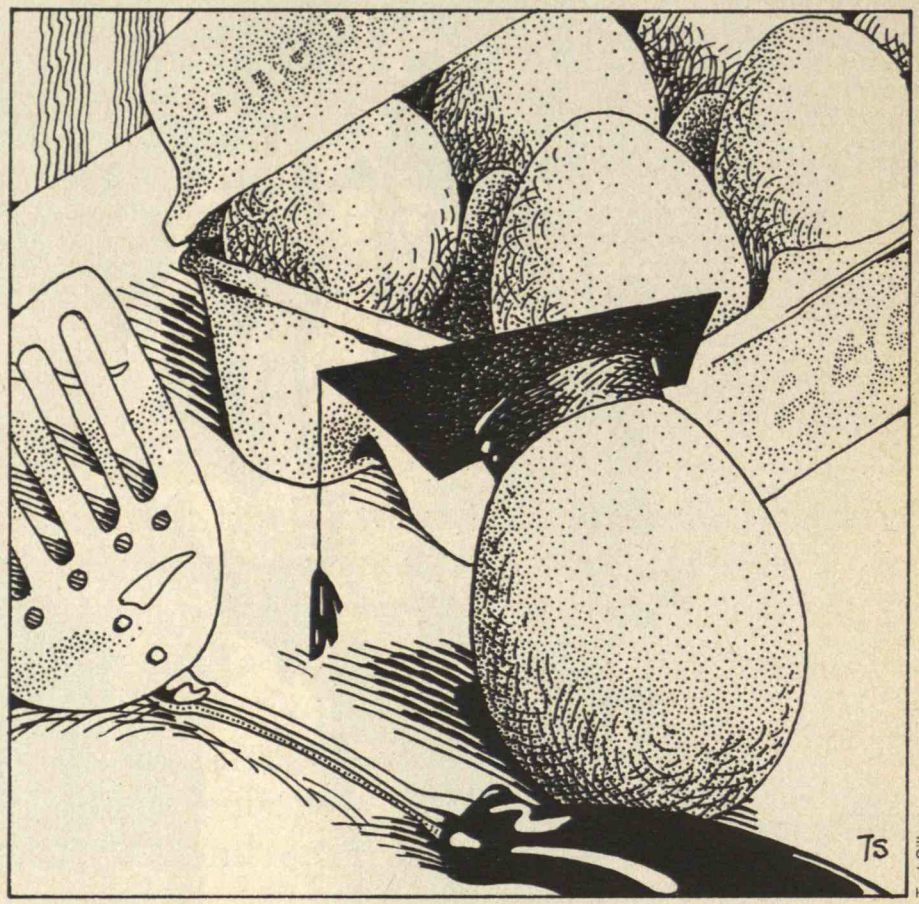
So you see, Xerox information management systems are actually the epitome of the work ethic.

They work harder. So you can work better.

XEROX

A Grading Experience

Kenneth E. Boulding is Director of the Institute of Behavioral Science and Professor of Economics at the University of Colorado at Boulder. He is a regular contributor to Technology Review.



Ted Sillars

I have just gone through the culminating moment of a professor's semester by turning in close to 200 student grades. A grade sheet is the teacher's only clearly identified tangible product. What the students have learned is hidden somewhere under their hair. Their subtle changes in brain structure are quite imperceptible even to our most expensive instrumentation. The grade sheet, however, is solid, real, and perceptible. I have sometimes indulged in idle speculation about how long it would take anybody to find out if I simply turned in a grade sheet of random grades and did nothing else. I should add hastily that I have never taken this idle speculation into practice.

Even after 40 years of teaching, however, I never turn in a grade sheet without a slight sense of guilt. Have I really been just? Am I too soft hearted? (The answer is probably yes.) Should I have given Ms. Jones that A and Mr. Smith that C? Should I have classified the grades more finely and sprinkled plusses and minuses over them? Have I blighted someone's career by reading their examination paper when I was tired or dispirited, or had just read a very good paper beforehand and was in no mood to be ambiguous? Incidentally, in the American system the grade is only a very small part of the student's total record. One hopes that whatever injustices one may have committed will be counter-balanced by the grades given by other people. One trembles indeed at the awesome responsibility given to the examiners at Oxford and Cambridge, where grades on a single examination at the end of a student's university career stamp an ineradicable tattoo of failure or success on the rest of a person's life.

Considering that grades are the only physical product of a teacher, surprisingly little thought has been given to them. As an institution they are remarkably stable. They inhabit the world of magic ordinal numbers — the famous 7, plus or minus 2. Traditionally there are the five (7 minus 2) standard grades: A, B, C, D, and F. I remember in Oxford the famous grade of Beta query minus, which leads into percentage grades: B = 85, B? = 84, B− = 83, B−? = 82, B−− = 81, BC = 80, and so on. However course or fine the distinctions, the institution of grading rests securely in the fact that the main social function of formal education is certification rather than learning. The grading of students is not all that different from the grading of beef or eggs.

Grade Inflation Beats Price Inflation

There has been a good deal of complaint in recent years about grade inflation, though in an age of inflation this seems like a slightly hollow complaint. However, it is true that a C has become a B, and a D has become a C. This is not confined to academic life, however. I recall a delightful grading system — I think for California olives — in which the lowest size is labelled "gigantic" and the highest size "super colossal." It is, however, a fundamental principle of economics that relative prices matter much more than absolute. Gasoline at 80 cents a gallon today would be about the same relative price that gasoline at 20 cents a gallon had in 1932. We have had a fourfold inflation in the intervening decades.

Grade inflation at least has much sharper upper limits than price inflation. There is no place to go beyond an A, or A++. There may, however, be a reduction in grade differentiation, and even on the conventional scale we have seen this. Another aspect of the same movement is the demand for pass-fail grades, an even greater reduction of grade differentiation. Pass-fail, however, is a bit unstable. It tends to edge over into "high pass," "pass," "low pass," and "fail," and we are back at least to A, B, C. and F. D indeed seems to be the major victim of the movement for grade inflation. But D is a pretty miserable fellow anyway that nobody can be very enthusiastic about, so perhaps we can kiss him goodbye.

Mediocrity Encouraged

Everybody who wrestles with grading somewhere in the back of the mind is aware of the tenuous and ambiguous relation between cardinal and ordinal numbers. It is customary in this country to grade on a scale of 100, 90 to 100 being

(Continued on p. 83)

We pay these scientists to make our production lines obsolete.

As soon as there's a better way to do something, the old way becomes obsolete.

And these scientists do nothing *but* design new and better ways for Western Electric to manufacture products for the Bell System. In the last two years, they and their colleagues at Western Electric's Engineering Research Center have helped cut costs by over $156 million.

They are a vital part of Western Electric's commitment to helping the Bell System keep the cost of communications service down, while keeping the quality up.

The Factory's Laboratory

The people at our Engineering Research Center work full time on manufacturing research. Over 50% of them are PhD's.

At home in the factory as well as the lab, they turn theoretical experiments into real savings. For example, while exploring ways to improve production of telephone circuit boards, they invented a totally new material with which to make the boards and a whole new way to mass-produce them.

Another breakthrough is already saving more than $2 million a year. It's a new soldering technique that makes 20,000 connections in less than 60 seconds.

The list of money-saving developments goes on. A new computer program that makes technical drawings in one-fourth the time of manual methods. An automatic system for sorting telephone parts by color. A process that measures the production of optical fiber 1000 times per second, keeping its diameter accurate within 30-millionths of an inch. And there's a new system that takes only 30 seconds to help align tiny integrated circuits that are 200 times thinner than the thinnest human hair.

These are just a few examples of what the Engineering Research Center does throughout *all* of Western Electric's manufacturing operations—developing new ideas in technology to improve telephone products and produce them at lower cost.

Anticipating the Future

Much of the work of the Engineering Research Center is designed to keep Western Electric ahead of technology, by anticipating what new processes will be needed for tomorrow's products.

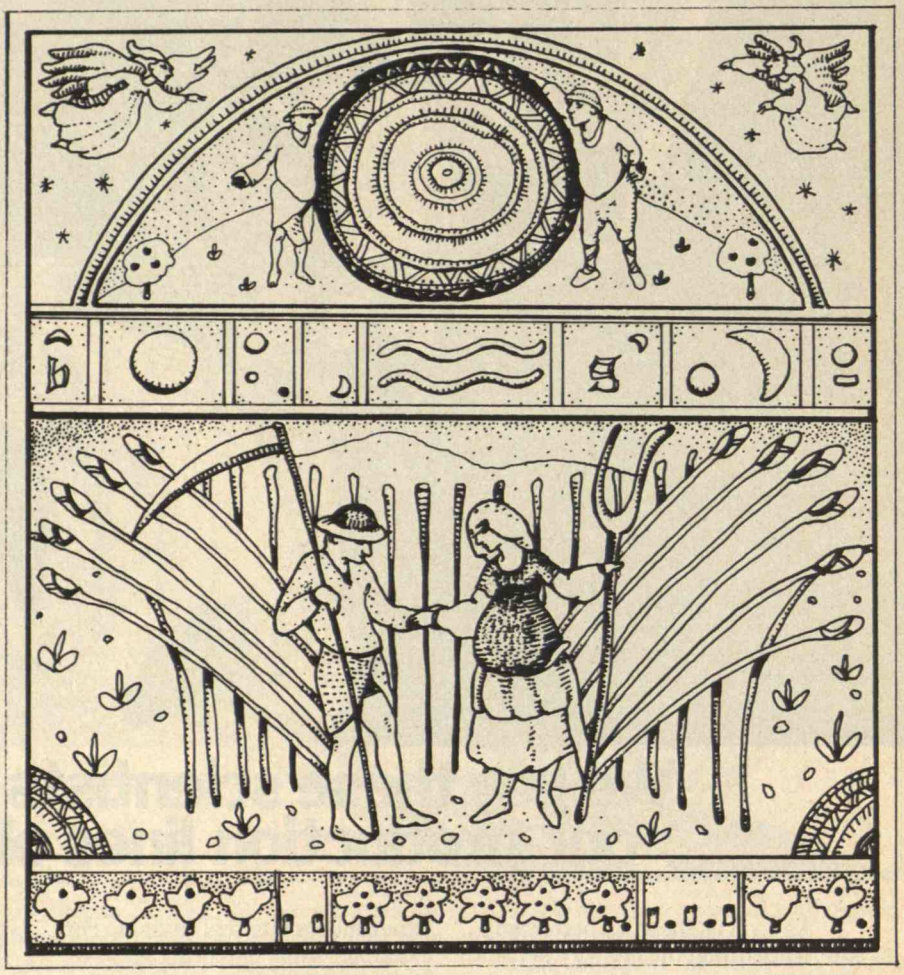
It's a total and ongoing commitment. A commitment to provide you with the highest quality telephone service at the lowest possible cost.

Keeping your communications system the best in the world.

Western Electric

Climate: Can We Read the Future in the Past?

Robert C. Cowen, Science Editor of the Christian Science Monitor, *is former President of the National Association of Science Writers and is a regular contributor to the* Review. *He holds S.B. and S.M. degrees in meteorology from M.I.T.*



S. J. Shue

For geologists, it is an article of faith that the past is a guide to the present. Meteorologists would like to say as much for weather and climate and their impact on civilization. But when reliable instrumental records peter out rapidly in the past — at best, and in only a few places, they go back little more than a century — such an aphorism seems to have little practical relevance. Nevertheless, in the spirit of the late Percy Bridgeman, the Harvard physicist who defined scientific method as "doing one's damnedest with one's mind, no holds barred," a few intrepid scholars are determined to use whatever clues they can lay hands on. They have faith that, by reconstructing a reasonable impression of past climate they will be able to judge better what climatic stresses mankind soon may be facing.

Are instrumental data lacking? Then use "proxy" data such as tree rings whose growth reflects such climatic stress as drought and whose dates can often be fixed to within a year. Or consult reports of grape harvest dates in European wineries and grain harvest dates in medieval manor records for indications of seasonal temperatures. Personal diaries, almanacs, and miscellaneous government records are also possible sources of weather information. And what of the artist's perceptive eye? Might not Constable's clouds, Bruegel's winter scenes, or Swiss landscapes showing glacial advances and retreats mirror climatic trends?

Great pitfalls and great promise lie in this uncertain line of research. But as H.H. Lamb of the University of East Anglia observed in opening the International Conference on Climate and History this summer, we badly need more knowledge and less theorizing about climatic change — knowledge as to what actually did happen in the past. If getting that knowledge means venturing into the wilderness of proxy data and musty documents, then so be it. For many years, Professor Lamb has been the major prophet crying in this wilderness. Now, in his emeritus years, he has the satisfaction of seeing this kind of research becoming an important field of inquiry.

A Global Puzzle

The conference brought together researchers from many countries, including the People's Republic of China where usable weather records run many centuries into their past. Conference reports showed that, as scholars begin to take this field seriously and to search systematically for information, there are possibilities for a global reconstruction of climate for many centuries, perhaps indeed millennia, past. Dr. Lamb noted that the past thousand years especially seems promising. Research already done has enabled the Climatic Research Unit (which he established at the University of East Anglia) to sketch climatic trends.

Outlining these as a backdrop for the conference, Dr. Lamb noted that this millennium is well suited for study because it has had a wide range of climatic regimes. To begin with, there was the warm epoch of the High Middle Ages which affected about two-thirds of the northern hemisphere for several centuries, lasting in Europe until about 1300. The warmth seems to have had a peak a few centuries earlier in Greenland and the Arctic. This suggests that cooling in those regions may have been linked to increased storminess in the North Sea and Atlantic after 1200 A.D.

Then climate underwent a series of changes that led into the colorfully named "Little Ice Age." This is a long period of relatively cool, unsettled weather — broken often by good spells — lasting from about the mid-16th century until the early 18th century. It was a period when the extent of northern hemisphere snow and ice seems to have been greater than at any time since the last true ice age. Dr. Lamb observed that "this Little Ice Age probably ranks with the warmest postglacial times around 4,000 years ago as the only times when the mean climatic conditions seem

to have departed in just one direction everywhere from those of the present century."

Finally, there is the present century itself which, from the viewpoint of climatology as a science, may have been the most disasterous of all. For this was the time when, in early decades, climate was relatively benign. The false notion arose that climate is inherently so stable that it would vary only slowly, so one needn't be concerned with sharp, short-term variations. This discouraged active climatic research. At the same time, the misleading notion of "normal" climate has little meaning. There is no norm toward which the weather is striving. Furthermore, with so little knowledge of the past, it is impossible yet to say much of anything about climatic variability beyond the kind of rough outline Dr. Lamb gave. Hence his comment on the need for knowledge, not theory.

In developing this knowledge, meteorologists should resist the temptation to waltz in and trip themselves up where experienced historians would tread cautiously, warned David J. Underhill of the Climatic Research Unit. Old documents are often not what they seem to be. A detailed daily almanac of weather observations may turn out to be a copy, not an original. Indeed, old-time authors often borrowed from other sources, and from each other, without credit. Thus what appear to be several independent reports of weather events may all be the same basic source that perhaps has been altered in the copying. What appear to be precise dates may be only approximations because of a tendency to relate events to the nearest Saint's Day. Terms may have changed meaning over time — as when a document refers to mist when it means fog. Even paintings that appear to be literal depictions of landscapes showing weather phenomena can be misleading. Often these will have been done in a studio on the basis of field sketches. The date on the picture then may be several years after the actual sketches were made.

"The use of materials foreign to the established methodologies of empirical science has not proved easy," Dr. Underhill lamented; "scientists have had to learn painful lessons." Nevertheless, having learned those lessons, he said, documentary evidence is an important source of detailed information especially from about 1100 A.D. onwards in Europe. Some of the information is indirect, but revealing, as in the case of vine harvest dates and other harvest dates. Such dates, which often had to be recorded as a matter of official public record, are often supplemented in old documents by observations of distinctive seasonal phenomena, such as first flowering of typical plants (so-called phenological data).

Putting the Puzzle Together

One of the meeting's highlights was a report by C. Pfister of Bern University showing how such information can be systematically studied, coded for computer analysis, and made to yield reliable information on climatic history. Searching Swiss archives, he has come up with what he calls "an unexpected wealth of historical information on climate." Combining this with proxy data (from tree ring studies, pollen analysis, or glacial studies), he has derived monthly weather patterns for Switzerland during three centuries from 1525 to 1825.

In doing this, he explains, the payoff came from painstaking efforts to verify historical sources and careful interpretation in which he balanced written observations of weather against the indications of proxy data. Generally, he found that proxy data suggest the magnitude of the temperature departure from average while the observations written about weather establish the timing.

As an example, he explains: "If an observer describes that the month of May in a particular year has been very dry and hot, while another reports the opening of the first vine flowers towards the end of the month, the qualitative statement of the first observer is confirmed by the quantifiable phenological observation of the second. Based upon the analysis of modern phenological data, it can be estimated that such a month may have had a heat excess of at least 1 to 1.5 degrees C. If, however, the statement is based upon phenological evidence alone, the bias can be considerable; due to an exceptional heat excess in early spring (February to April) the vegetation can be so advanced that an early vine flower is no longer a safe indicator of a warm May. Thus we need the mutual correpondence of observation and proxy-data."

One of the most important aspects of Dr. Pfister's work is the elaborate coding system he has developed to represent his data. There is coding to show the source of an item of information and an estimate of its reliability. There is coding to represent that information in fairly fine detail. Thus he has been able to put his data into a computer store from which he can easily retrieve it and within which he can analyze

(Continued on p. 83)

by Bernard Zubrowski

Teaching Technology To Children

A special kind of learning occurs when children re-invent ancient technologies.

In the context of contemporary culture, pre-industrial technology must seem rather primitive. A great deal of work was done by hand using simple tools. Materials were indigenous and often used in their rough condition. Methods and processes were direct and quite lengthy. Today, in comparison, computers control complex machinery which work on a tremendous variety of man-made materials — producing products quickly and in quantity. If one were to take a close look at ancient technology, it would become apparent that a great deal of thought, experimentation, and observation went into the development of the various tools and processes used by craftsmen. In fact, in their own way they were as much practicing a form of science as people in laboratories do today. Different in kind, no doubt, but they brought some kind of order to the diversity of nature nevertheless.

Bringing Children to Technology

As a museum educator interested in designing science programs for children, I find this history a very rich area for children to explore. Many of the actions of older tools and processes are immediate, visible, and comprehensible at a concrete level. The weight of water falling on a water wheel can be seen and felt, and the resulting conversion of energy into work by way of gears is easily followed. The operation of simple tools is readily understood; their movements are directly visible and easily controlled.

The older technologies have another appealing aspect especially suited for children: their close relationship to the arts. The movement of wind mills or escapements in old mechanical clocks have an aesthetic dimension often ignored. Some of these devices and machines could rightly be called the first kinetic sculptures. Cyril Stanley Smith, professor of the history of technology and science at M.I.T., has pointed out that practitioners of technology, until recently, were more closely akin to artists, than scientists in how they approached materials. (*"On Arts, Invention, and Technology," June, 1976, pp. 36-41*)

A personal fascination for some devices of older technologies, and a recognition of the need for programs on technology for children, have led me to develop exhibits, programs, and educational materials which give children the opportunity to explore specific topics under a general theme of Ancient Technology and Crafts. Recently, the Children's Museum collaborated with the Thompson's Island Education Center, located in Boston Harbor, in sponsoring a four-week summer program for children during which they had the opportunity to work with models of ancient and medieval machines and tools. The results of this program as well as other programs conducted with Boston school chidren of many ages have indicated that a wide range of subject matter

Ancient technologies are an engagingly direct way of teaching scientific principles to children, thinks Bernard Zubrowski (at left, above). He has developed programs for a variety of ages which include toolmaking, waterpumps, wind machines, and shelters. (Below) The conversion of energy by a water wheel is concretely understood as the weight of water is made to move gears.

Photographs by Chris Maynard

(At right) Building shelters should involve the child's whole body so he can actually feel the forces which hold them up. More often, children are asked to make small models in which the effect is largely visual, demanding fine motor skills.

(Left column) The operation of a pump drill involves a non-verbal kind of learning in which the child must experiment to create the right rhythm and pressure. In this direct communication with the materials, learning is achieved by action rather than words. (Below) By swirling ink in a water-filled pan currents can be observed.

can be addressed and that a special kind of learning occurs. This special kind of learning can be illustrated by relating what children actually did during this summer program.

The topics explored were tools and toolmaking, ancient waterpumps, wind machines such as sailboats and windmills, and shelters. The emphasis was on the construction and manipulation of models which were constructed with everyday materials. Occasionally, when available and appropriate, artifacts from the museum's collection were shown to the children to give them concrete illustrations of the topics they were exploring.

Experimenting, Imaging, Creating

The activities under toolmaking followed an historical sequence: starting off with stone tools and ending up with machine tools such as the pole lathe. During each session children had the opportunity to make tools or to operate them. They worked at breaking and chipping rocks to make primitive scrapers and knives; forged drill bits by heating up nails in charcoal fires and flattening them with primitive hammers. They operated pump drills and pole lathes to make small wooden beads. The operation of these machines was quite fascinating to children and they spent hours working with them.

What becomes apparent in watching children in this type of activity and program is that they are fully involved and

learning. The type of learning is not easy to characterize because it is different in nature from that usually associated with school. For instance, it takes more than a verbal explanation to get across to children how to operate a pump drill. If the paddle on the drill is not pushed up and down with the right rhythm, the drill will either stop or the bit will get stuck in the hole. The child has to operate the drill, experimenting with the right kind of pressure and rhythm in order to understand how it works. What comes into play in this situation, as in others during the program, is a nonverbal type of thinking: a continual imaging of possible arrangements based on the immediate situation is needed to achieve the right kind of result. Children become involved in a direct dialogue with materials or model where the action itself is the form of communication rather than words.

This type of thinking is further experienced when children build structures. Usually, when they are presented with such opportunities it is mainly small models that are solicited. This does give them some visual feeling for the structure, but the effect is mostly visual and primarily involves fine motor skills. By providing them with larger materials and encouraging them to build houses as tall as themselves, they get their whole body and more of their senses involved. What results is a situation where they can literally feel the forces holding up a house.

In the summer program, children were encouraged to build houses and structures of their own design. Small groups of five or six campers were given dowels, broomsticks, and rubber bands; and with a little instruction on how to join the sticks together with string, they were left on their own. A variety of shapes evolved. One group made a regular square frame house, while another somehow ended up with a pentagonal shape. With all these houses, there were continual problems of making them rigid and strong. Children discovered a variety of ways to cope with this problem, either by banging the sticks in the ground at the corners or putting diagonal pieces at the corners. These houses did manage to stand up for several days, but none stood up for the entire program. It was a continual challenge to the campers to come up with new ways of putting together some kind of structure. The process of additional planning and revisions became an end in itself, because of the adventure associated with each new construction.

(Top) The drift of a balloon tells about the currents of the wind.

Personalized Solutions

In the development of technology, there are often a variety of solutions for the same kind of problem. For instance, in ancient times a variety of techniques and devices were used to lift water for irrigation and household use. Likewise, sailboats had diverse arrangements for sails and differently shaped hulls, although all could be reduced to a basic design with a mainsail set in the center of the boat. This aspect of technology, in which there is more than one way to approach a problem, is useful to emphasize. It directly relates to some of today's problems and it also provides a context in which children can be encouraged to be creative and personalize their solutions to problems.

The exploration of wind machines is a good example of this. Children were encouraged to design sailboats and wind mills. The boats were made from half-gallon milk cartons, and the hulls, sails, and rudders were fabricated from different parts of the carton. The test tank was a long trough made from scraps of wood, lined with a plastic drop cloth to hold water. Wind power was provided by a large window fan.

A great variety of boats were constructed, from catamarans to double-masted schooners. Each child came up with his or her own special design; practically all were different from each other, although all did have some kind of main sail in the middle of the boat. The essential test in each case was whether the boat could make it from one end of the tank to the other without tipping over. This particular activity was probably the most popular.

A similar development occured during the activities with waterpumps. Following chronological sequence, children had the opportunity to play with working models of a shadouf, an archimedes screw, a noria, a rag and chain pump, and several kinds of force pumps — each an example of how ancient farmers lifted water for irrigation made from household materials. Engaged by the variety of devices and the relative simplicity of the problem, children became easily involved in coming up with their own inventions for lifting water. At first their inventions were quite similar to the working models, but after considerable fiddling around with little successes and failures, they began to come up with their own particular devices. Often these did not work very well or not at all, but they were quite persistent. The products, after all, were their own ideas.

There are other aspects to the subject of water machines which are important from an educator's point of view. In addition to the opportunity for creative problem solving, various levels of learning present themselves. First, water has a universal appeal, children of all ages and temperment just can't resist playing with it. The various machines and devices used in the program also have an intrinsic appeal. Thus, the motivation is built into the materials and the program leader doesn't have to provide it. Basic physical principles are dealt with in a concrete fashion and are repeated several times throughout the course of the program. By comparing rates of water delivery among the different models some mathematics are introduced. Depending on the level and interest of the group, a little of the history of technology can be conveyed. Finally, but not least of all, the movement of water through tubes and the movement of the machines themselves, have aesthetic dimensions that can be exploited for the making of kinetic sculptures or as a take-off point for a theatrical skit.

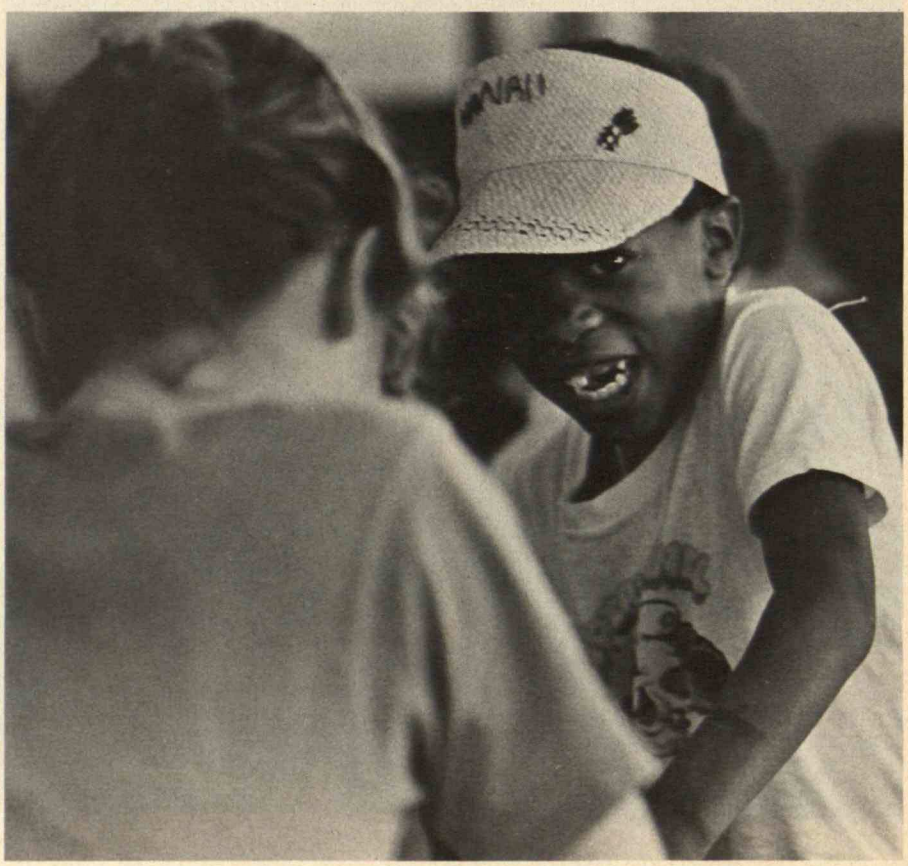
The last description could be applied just as well to the other topics in the summer program. The motion of sailboats or of machine tools has an intrinsic appeal and provides high motivation for direct involvement. Various physical principles and historical facts can easily be integrated into the flow of these activities. Given this initial success, future programs at the Children's Museum will attempt to further exploit these topics as well as search for other topics that hold similar promise. For instance, Dyes and Pigments along with Breadmaking and Fermentation, offer interesting possibilities for conveying to children examples of the early development of chemistry.

Overall, these activities develop more than an understanding of the history of technology and of some basic scientific principles. The kind of materials chosen and the way each was introduced imparted a philosophy of how one lives in the world and some hints for solving to-

Tennis ball, milk cartons, sticks, and cans capture the wind from a household fan. . . . A few adjustments and the enthralled result!

Children need little encouragement to play with water and motion. But learning is rich as well. Their delight in finding individual solutions provides the insight that there are many approaches to solving problems. The use of everyday materials is an invitation to explore their own environment.

day's problems. In all the above topics, household materials were used: houses were constructed with broomsticks and dowels; plastic cups and pie plates formed water machines; milk cartons provided the raw materials for boats. This was done for more than economic reasons. We were trying to show the children that today, just as in the past, the materials that are right around us can be exploited in a variety of ways. This means more than just recycling them; we are suggesting that one's immediate environment is a rich area for in-depth exploration. In addition, by playing with working models of water machines and wind machines, children can have the direct experience of knowing that alternative sources of energy are possible. Thus, by delving into ancient technology children can play at being artist, inventor, or scientist while at the same time gaining knowledge relevant to contemporary society. □



Bernard Zubrowski is on the staff of the Children's Museum in Boston. He also teaches at the Boston University School of Education and is the author of three books which describe science experiments using household materials, recently published by Little, Brown and Co.

Spiders

E.O. Wilson: Let me remind you that people everywhere, a large percent of the population, at a very early age have already developed a deep horror at the sight of snakes or spiders with nothing more than gentle nudging from their parents, if that. Yet, in spite of the fact that parents constantly reinforce their children against going near electric sockets, automobiles, knives and the like, phobias against such objects rarely develop.

Marvin Harris: Let's go back again to the possibility that these phobias are genetically programmed – which I'm willing to grant. The overwhelming bulk of the socially conditioned response repertories of different human societies consists, by your own admission, of culturally determined rather than genetically determined traits. Then it seems to me that when one offers a cogent culturological explanation of these ph
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such gigantic phenomena as the
rgence of state-organized societies or the emergence of stratified classes and castes. The enormous differences between industrial civilization and pre-industrial societies, peasant or village ways of life

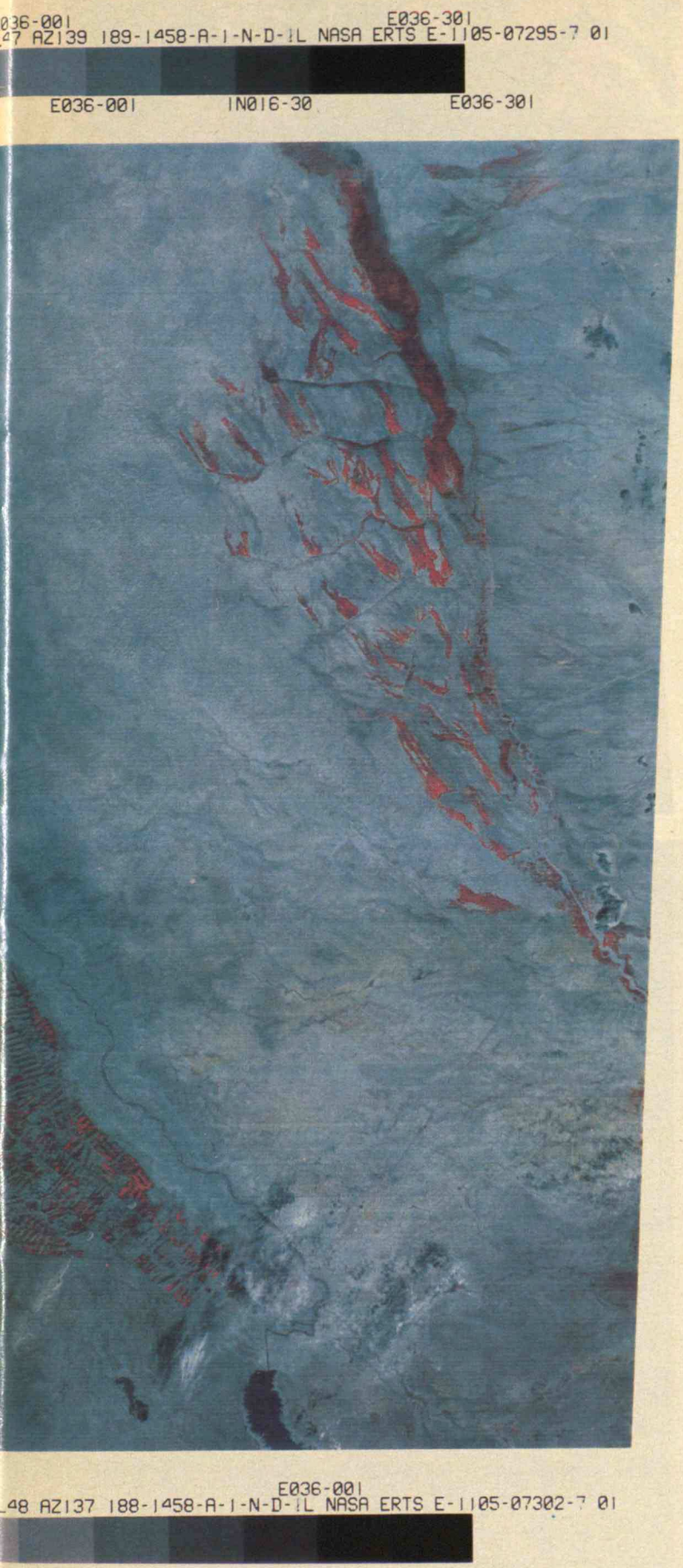
Satellites and World Food Resources

by Charles K. Paul

Ask an average U.S. citizen what satellites are used for and he or she will probably think of transoceanic telephone calls, long-range weather forecasting, and live television programming of events taking place half-way around the world. These and many other functions are performed by communications and weather satellites. Less well-known are a third group of satellites — the earth survey satellites — that take pictures or images of the land and oceans of our planet. While some of these satellites are used for military surveillance purposes, others play a unique and important role in land-use management programs. Satellite imagery enables scientists to map and inventory the vegetation and geomorphology (i.e., "the lay of the land") more accurately and rapidly than is possible using aerial photographs.

One of the most important applications of this technology is to facilitate the management of agricultural resources, particularly in less developed countries (LDC's), where the need for improved agricultural information is a paramount factor in economic development. The United States, through the U.S. Agency for International Development (A.I.D.) and other agencies, has been using and transferring this technology to LDC's in a variety of agricultural and natural resource management programs.

The principal satellites used by A.I.D. in this mission have been three Landsat satellites launched in 1972 (now defunct), 1975, and 1978. These satellites represent the primary source of most resource



Crop production estimates are vital for the developing countries, but few have information systems that can even begin to generate them. This is where satellites and image analysis technology can help.

imagery taken since 1972. The Landsats primarily image with a Multi Spectral Scanner and have a ground resolution of 80 meters. Images are digitized aboard the two Landsats and either transmitted directly to a receiving station or stored aboard a tape recorder for later playback if the satellite is not within 2700 kilometers of a receiving station. The "raw" digital data can be converted to black-and-white as well as color images, digitally processed to make an enhanced image, or digitally classified into a land use map.

Landsat products are available to the public through the U.S. Geological Survey's EROS Data Center in South Dakota. The foreign interest in Landsat technology is evidenced by the proliferation of Landsat receiving stations; in addition to the three in the United States, Canada has two, and Brazil and Italy each have one. Development of stations is under way in Iran, Argentina, Japan, India, Sweden and Australia. Stations are scheduled to be developed in Upper Volta and Thailand.

Figure 1: A Landsat scene of an area along the Nile River. Forty-two such images cover all the fertile growing areas in the Sudan.

The Agricultural Information Gap

With 455 million people in the world on the brink of starvation, there is clearly a need for improved development and management of the world's agricultural resources. This need was stated as recently as October 1978 at the Large Area Crop Inventory Experiment (L.A.C.I.E.) Symposium held at the N.A.S.A. Johnson Space Center: "Fluctuations in the food supply (caused by periodic droughts and energy shortages), coupled with an ever-increasing demand resulting from an expanding world population and an improving standard of living in the less developed countries, have increased the need for more effective approaches to the management of global food production, storage, distribution, and marketing."

One of the most vital pieces of agricultural information for LDC's is crop production estimates. Advance knowledge of probable crop outcome enables LDC governments to determine the optimum level of foreign food assistance needed to complement domestic production. If production estimates indicate a crop shortfall, a possible food shortage can be offset by requests for increased food relief supplies long before a famine situation arises. On the other hand, if projections indicate that crop production will be larger than normal, LDC's can request decreased food shipments to ensure that food prices are not reduced by a glut, which would prevent local farmers from getting fair market value for their crops.

Unfortunately, fewer than ten countries in the world have agricultural information systems that can even begin to provide the data necessary for making crop production estimates. Half of the developing countries of the world have either no agricultural information systems at all, or, at best, very simple systems that are only of limited use. Except for an agricultural census every ten years, the only crop reports available to these countries are from agricultural attachés at various embassies in the country, foreign statistical publications, commodity periodicals, Reuters commodity reports, the commodity trade itself, foreign newspapers, and the wire services. Most of these sources are entirely inadequate for generating crop statistics.

Why don't developing countries adopt improved systems of agricultural reporting? Basically, most LDC's do not have the technical capability to collect or analyze the data because it is too expensive to purchase the technology from industrialized nations.

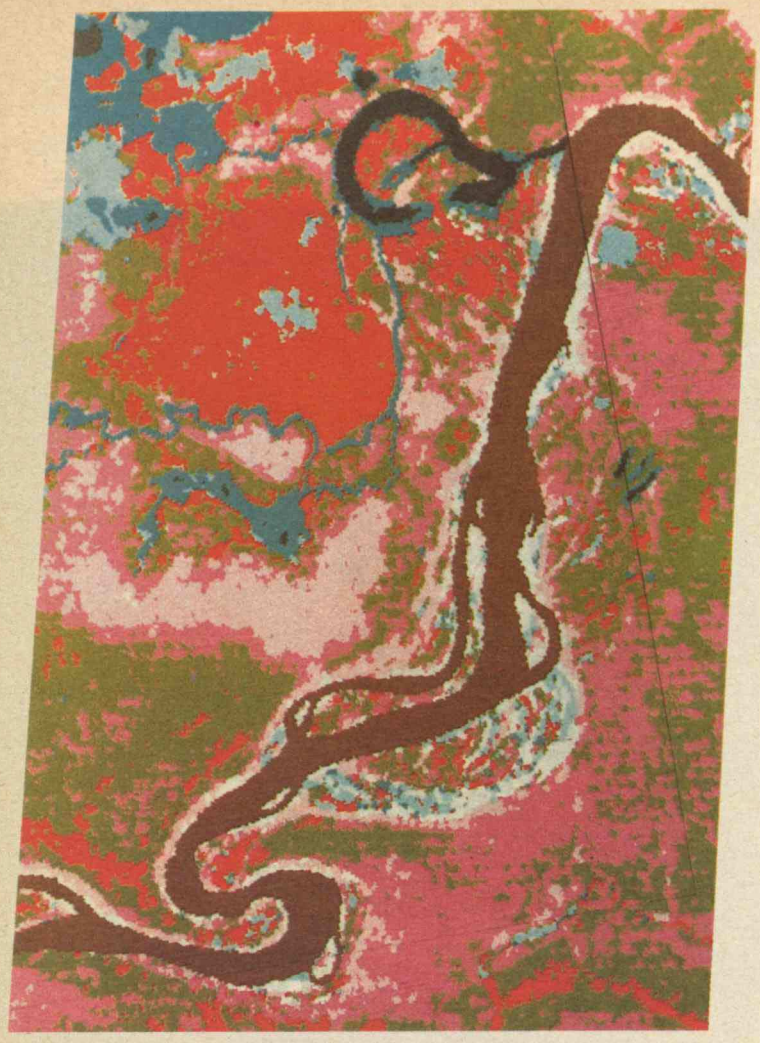
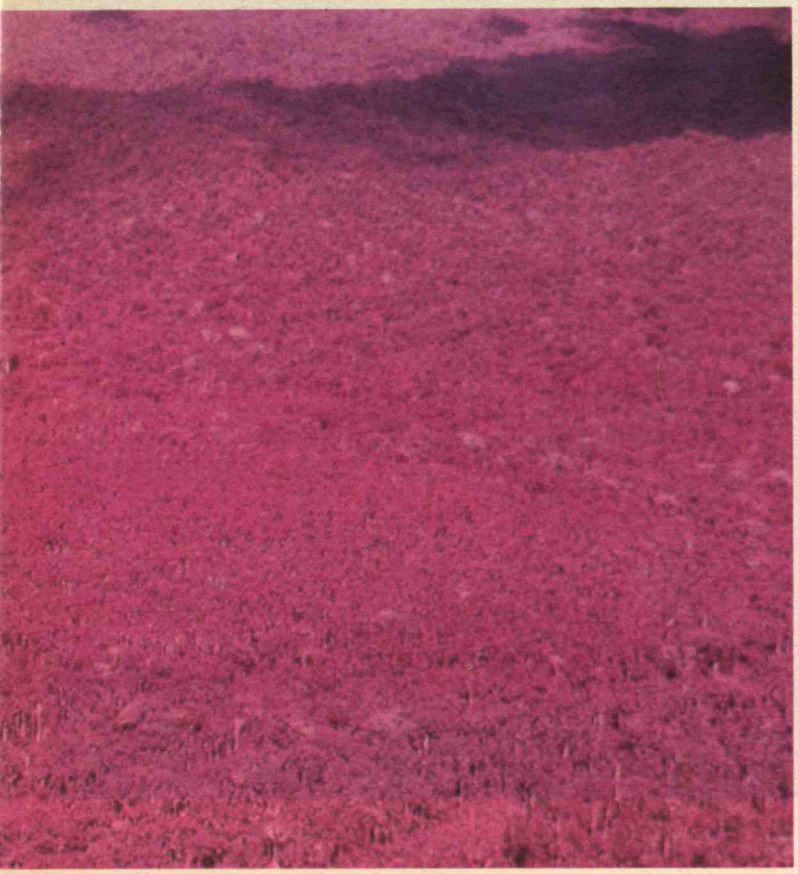


Figure 2 (*far left*): A Landsat image — near the town of Iquitos in Peru — to identify stands of aguaje palm (depicted here in peach).

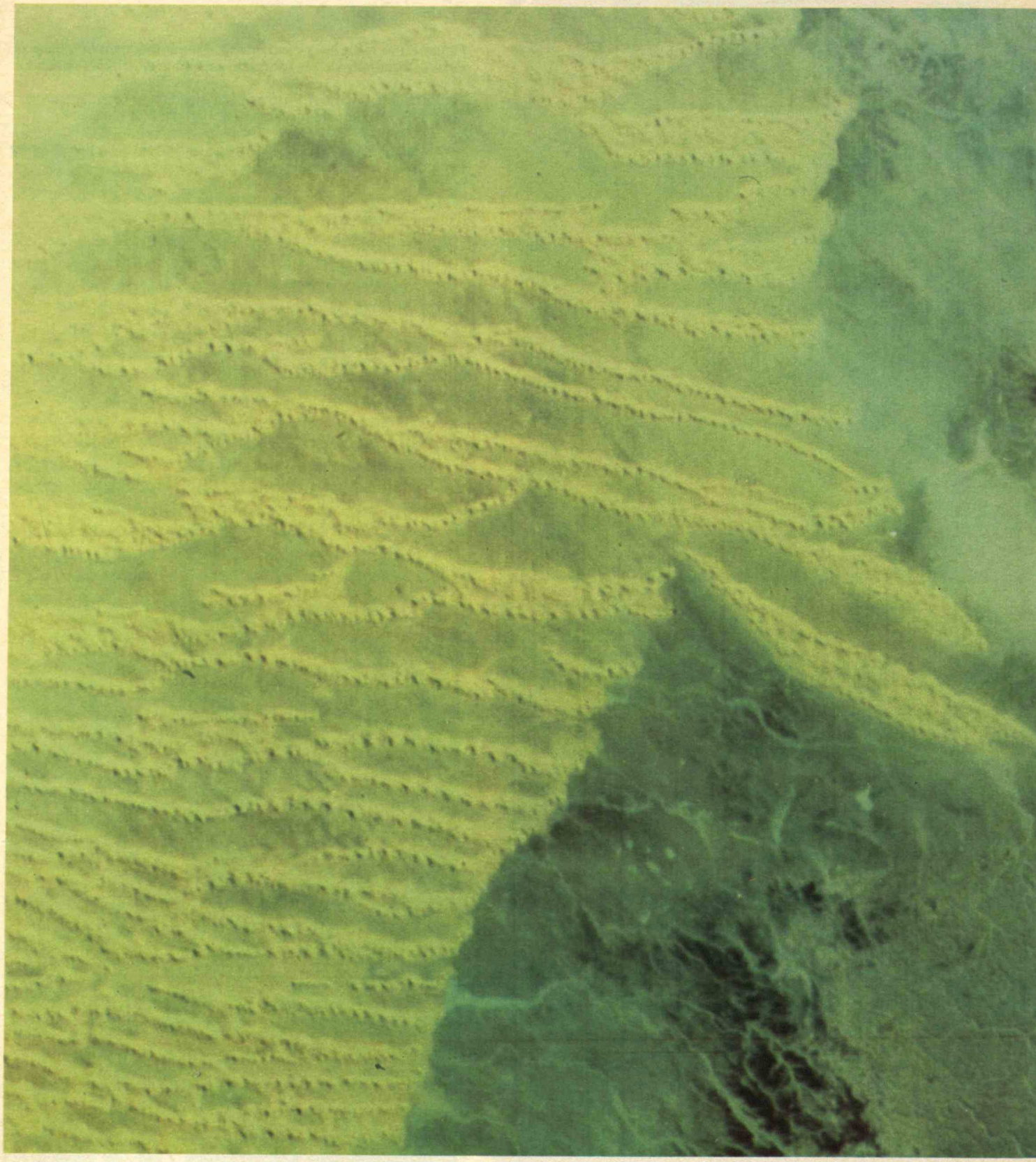
Figure 3 (*left*): Another Peruvian Landsat image (the Concordia Test Site) with aguaje forests shown in light and dark pink.

Below left: An air photo of a Peruvian rain forest. The fine-grained center area is a stand of aguaje palm.

Below: A close-up of the aguaje's fruit.



A Landsat image of encroaching sand dunes in west Sahel.



And because they have no technological base upon which the benefits of improved data collection can be quantified, they cannot argue to allot larger shares of their national budget for data collection. What the LDC's need to break out of this vicious circle are good quality data; rapid turn-around in collection, reception, review, and reporting of crop statistics; and data processing hardware to synthesize, compile, and forecast national production. This is precisely where satellites and image analysis technology can help. Satellites can provide objective data on very large areas of land within a short time frame. Civil survey satellites have sufficiently gross image resolution and limited information volume that national crop summaries can be rapidly prepared from the data and used to make crop management decisions.

Remote Sensing Technologies for Crop Statistics

Satellites can be used in a variety of ways to provide crop statistics. The available technologies vary in their capital-to-labor intensity ratio. At one extreme is the approach used by the L.A.C.I.E. project — a joint endeavour of the National Aeronautics and Space Administration (N.A.S.A.), the U.S. Department of Agriculture (U.S.D.A.) and the National Oceanic and Atmospheric Administration to improve wheat crop estimates using Landsat data, climatological and meteorological data, and conventional data sources. The project was conducted over four years from 1974 to 1978.

Landsat data were used to provide area estimates for the major wheat-producing nations of the world. These estimates were then combined with historical yield data and current meteorological satellite data to derive wheat-production estimates. The project was most successful in predicting wheat production for countries such as the Soviet Union (that have large wheat fields and relatively constant climatological conditions). The L.A.C.I.E. technology will be developed further in a future research program.

L.A.C.I.E. is an example of a highly capital-intensive resource-mapping technology. It requires computer complexes and attempts to minimize human interpreters. At the other end of the scale is area frame sampling, a technique that extrapolates crop survey data for a large region from detailed surveys of representative areas within the region. Area frame sampling uses Landsat images, maps, and aerial photos to delineate homogeneous land use and soil themes, from which several hundred

fields are statistically selected for detailed field surveys. Ground surveys are then conducted to obtain data on crop types, acreage, yield, livestock numbers, and other socioeconomic factors. These sample statistics are representative of the region's entire agricultural potential. The entire potential is estimated by multiplying the sample statistics by the ratio of the entire land use theme area to the area comprising the sample fields. Areas can be estimated from satellite photographs using a hand-held planimeter, which generally costs less than a hundred dollars.

Area frame sampling is currently the most suitable technology for use in LDC's. It uses intermediate technology more likely to be found in developing countries and is labor-intensive, thus providing employment opportunities which are sorely lacking in LDC's. Also, when properly conducted, area frame sampling is one of the most precise techniques (approximately 95 per cent accurate) for predicting crop production. Area frame sampling is presently being used in joint U.S.D.A./A.I.D. projects in nine LDC's — Dominican Republic, Jamaica, Costa Rica, Bolivia, Ecuador, Morocco, the Philippines, Indonesia, and Thailand. Landsat imagery is critical — most aerial photography in the LDC's is hopelessly out of date, very expensive to replace, or militarily restricted.

Area Frame Sampling in the Sudan

In a current U.S.D.A./A.I.D. project, Landsat images are being used to construct an area frame for the fertile growing areas in the Sudan. Figure 1 shows one of these — a Landsat scene of an area along the Blue Nile. It is an ideal image for area selection. A stratum of large mechanized fields on the west bank of the Nile is contrasted with large, barren deserts. A stratum of even larger sugar cane fields can be seen in the center of the crop stratum. Along the eastern edge of the image lie strips of orchards and other cash crops irrigated by seasonal streams. Figure 1 is one of forty-two Landsat images covering all the fertile growing areas in the Sudan. Together, these images make possible the rapid selection of sample fields for conducting an agricultural census on the ground.

Mapping of the Peruvian Aguaje Palm

On the other side of the Atlantic, satellite images were used to help Peru identify and map one of her

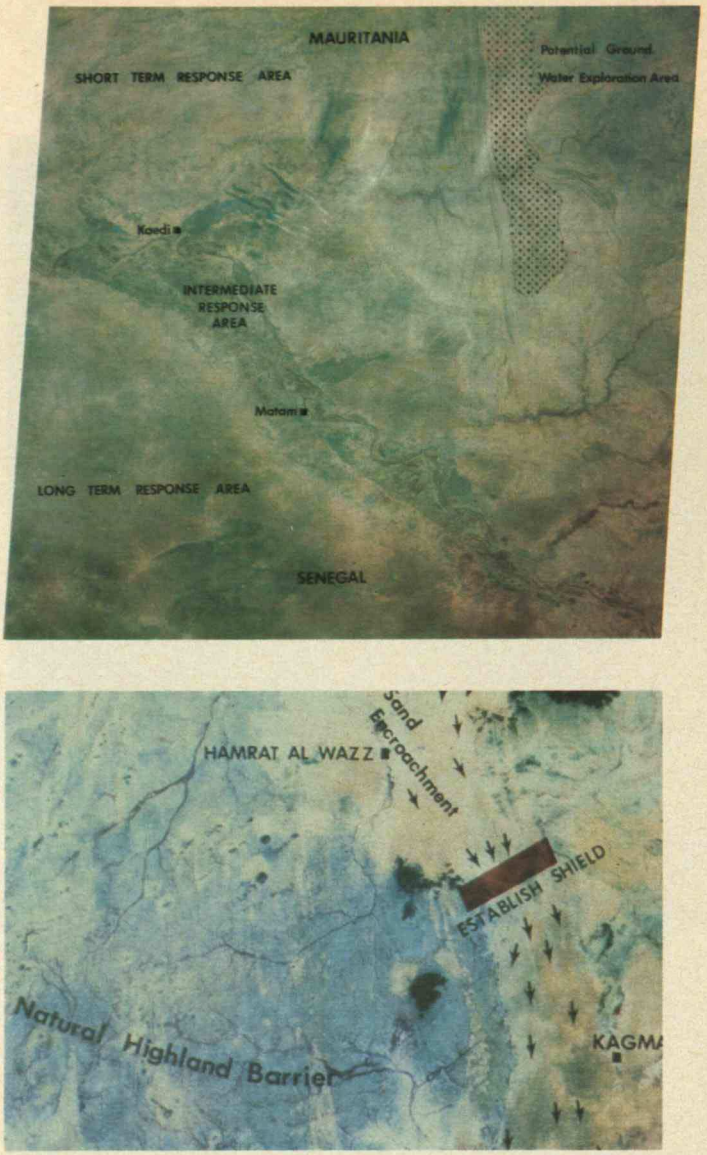


Figure 4 (*top*): A Landsat image of desertification, in the border area of Mauritania and Senegal, showing short-term, intermediate, and long-term indicators of drought.

Bottom: Sand dunes moving onto fertile agricultural land (near Kagmar in the Sudan) through a mountain pass. Establishment of a barrier (like a snow fence) could possibly stop them.

most valuable natural food resources — the aguaje palm. Aguaje palm grows wild in the Peruvian forests, in stands which can exceed many square kilometers in size. The pulp of the aguaje palm tree fruit is rich in lignocellulose and hence used in small rural wood pulp industries in the region. Even more important, the kernel of the fruit — 50 per cent vegetable oil by weight and rich in vitamin C — is used as a food and as a cooking oil.

Peru, like other Andean nations, has been conducting a resettlement program to move populations from the marginally productive and ecologically fragile altiplano down to the more productive rain forest. The aguaje palm was viewed as an important food resource for the resettled population, but the extent of the palm stands, their location, their size, and the extent to which they must be replanted (based on present clearing of the palms) were completely unknown factors in these wild and inacessible areas. At the request of the Peruvian government, A.I.D. and the Environmental Research Institute of Michigan went to work to locate and map these valuable food resources using satellite images.

Figure 2 is a computer-processed forestry map generated by computer analysis of a Landsat data tape. The town of Iquitos on the headwaters of the Amazon River is near the top center of the map. The large, peach-colored areas represent the valuable aguaje palm stands, corroborated by on-site visits at selected samples along the Amazon River. Forests growing on alluvial deposits along rivers are shown in green while those on uplands are in yellow. Turbid rivers are illustrated in brown with towns in orange.

Figure 3 shows a second test site along the Marañon River, further to the west of Figure 2. This area, called the Concordia Test Site, has two density levels of aguaje palm — Aguaje Forest I (light pink) and Aguaje Forest II (dark pink). Other forest types permanently in water are shown as three different swamp species. Alluvial forests are in green, rivers in mustard, and lakes in olive. As a result of these and other Landsat images, much greater stands of aguaje palm were identified in Peru than were previously suspected.

Analyzing Desertification in the Sahel

One of the major applications of satellite resource survey technology has been the monitoring and study of desertification. Desertification is commonly recognized as a global ecological problem threatening the life-support systems of this planet. The process is occuring in north, west, and east Africa, west and south South America, southwest Asia, and the western United States. One of the hardest hit areas is the Sahel, a savannah-type region between the Sahara and the lush African rain forest that borders the Atlantic. The Sahara has gradually been creeping down into the Sahel, eating away at the region's meager agricultural resources. The process of desertification in this region climaxed in 1972 after five years of drought. Over 100,000 people literally starved to death, and two out of every three head of cattle perished in Mauritania, Upper Volta, Mali, Niger, and Chad. The Sahara began to creep further and further south, with drying up of rivers and lakes, salinization of water holes that remained, blowing sand dunes, loss of soil productivity, erosion, and disappearance of rangeland vegetation, followed by mass migrations of nomadic herders to the southern cities and towns.

Although the rains returned to the Sahel from 1973 to 1976 (i.e., the rainfall returned to average, but very marginal, amounts), intermittent reports from rainfall gauges and meteorological stations forewarned of impending disaster again in 1977. In an attempt to understand the continuing problem in the Sahel, A.I.D. decided to use Landsat images of the region to study the effects of desertification. At the request of the Sahel Development Office of A.I.D., N.A.S.A. turned on the Landsat Multi-Spectral Scanner and recorded imagery over Mauritania and Senegal in December 1977 and obtained fifteen high quality cloud-free images. Next, images covering the same areas for the years of 1972 and 1976 (very dry and wet years, respectively) were obtained from the image archives of the U.S. Geological Survey EROS Data Center. Analysis of the 1972, 1976, and 1977 images by A.I.D. and South Dakota State University resulted in improved knowledge of indicators of desert encroachment. For example, land cover changes in response to rainfall in the Sahel are now known for the first time, as well as the time required for these changes to occur. This land cover includes interdune range grass, riverine crops, and sparse vegetation sustained by relatively shallow aquifers along drainage basins.

Figure 4 is one of the fifteen Landsat images taken on December 10, 1977. It shows the Senegal River separating Mauritania and Senegal. The northern interdunal grass responds quickly to drought; i.e., several months of below-average rainfall causes the complete disappearance of this vegetation. This in-

terpretation was corroborated by A.I.D. nomadic migration records which show mass movements southward during 1977, as herders went looking for better pastures. The area labeled "Intermediate Response Area" is cropland irrigated by the Senegal River. Since it takes two to three years for the River to recede sufficiently to negatively affect this agriculture, we conclude that this land use has an intermediate response time. At the lower left of Figure 4 is an area of hardy vegetation with roots tapping subsurface water. Since this vegetation did not appear to have been affected by eight years of drought, it was classified as a long term indicator of drought, not too useful in alerting us to potential desertification problems. Other Landsat images of this area show lakes still being charged by underground aquifers one year after the 1977 drought started, even though the Senegal River was so low and turbid that it was barely visible on the image.

Analysis of the Landsat images not only improved our understanding of desertification, but also indicated some ways of alleviating the problem. For example, note the intersection of the east-to-west drainage feature with the north-south linear in the northeast corner of Figure 4. Note the lack of dendritic (i.e., branch-like) drainage features along the geological linear, suggesting the presence of a hard rock barrier between two relatively permeable regions on each side. This strongly suggests that subsurface water is being dammed on the east side of the rock obstruction, and this potential groundwater exploration area will be inspected in more detail to determine if water is available for several major A.I.D. development projects in this region.

Unfortunately, the identification of potential shallow groundwater may provide only short-term benefits if the water is misused. For example, one of the human causes of desertification is the concentrating of cattle around water holes. The cattle then deplete the vegetation which, in turn, causes valuable topsoil to wash away when it rains. The vegetation cannot reproduce on the eroded land, and cattle can no longer graze on it, whether water is available or not. Likewise, since most aquifers are somewhat limited in the Sahel, a concentration of cattle may deplete in several months a reservoir that has taken years to form. Thus, the manner in which the resource information generated by satellite imagery is applied is of critical importance. The information must be combined with sound land management practices in order to protect or most effectively develop our natural resources.

Data Versus Information

Satellites *per se* do not provide information, they provide data which must be converted to information by various interpretation techniques. The distinction is important. Although Landsat data are available to everyone, they are only useful to groups that possess the appropriate techniques for converting data into information. The developing world today well understands the limits of raw pictures and has been pressing the industrialized world for training and equipment to do their own data interpretation. A.I.D. and other foreign agencies are presently engaged in programs to transfer data interpretation technologies to LDC's.

The transition from imagery to map, or data to information, is accomplished by two very different techniques — photo interpretation and computer processing.

Photo interpretation, or visual analysis, is the technique of associating details of aerial or satellite photographs with surficial features and subsurface resources. For instance, mottled patterns may indicate specific types of vegetation, outcropping sandstone may be associated with water, and geologic linears may be signs of oil deposits. Photo interpretation can be relatively easily learned by resource specialists with experience in their disciplines. The best interpreters are geologists, foresters, hydrologists, and civil engineers. Visual analysis uses relatively simple equipment, such as hand lenses, acetate paper for maps, hand stereoscopes, light tables, and, for more detailed analysis, diazo color printers, zoom transfer scopes, and density slicers. A good visual analysis laboratory with a photographic reproduction facility can be built for roughly $300,000 to $500,000.

Further information on surficial features can be gained from an analysis of the spectral contents of image data, i.e., the different reflectances of sunlight from different earth materials. These differences are seen as various gray tones in black and white photos or various colors in color photos. Spectral analysis is best performed by computers, since the human eye cannot distinguish the many spectral differences which the sensor can measure over large areas. Computers can very rapidly group similar spectral responses into classes indicative of surface features that may be completely invisible on the corresponding pictures. For example, raw satellite and aircraft pictures of Bolivian salt flats reveal only the white salt and a few colors around the shoreline, but com-

Satellite images, and the ecological problems they pinpoint, transcend political boundaries. International cooperation is therefore essential for applying the results of remote sensing.

puter "classifiers" show up to ten different conditions in the salt associated with differing concentrations of salt brine and lithium deposits.

Computer techniques are important analysis tools because when used properly (i.e., with an interpreter familiar with the area under study) they can extract information unavailable by manual techniques alone. Unfortunately, the transfer of digital image processing to LDC's is a terribly complex task. Digital image processing requires personnel trained in computer programming and electronic maintenance, as well as mathematicians with specialties in statistics and pattern recognition, if the digital systems are to stay in repair and remain adaptable to changes. These types of personnel are at best difficult to find and at worst unavailable in many LDC's. Also, computer technology is very expensive. A fully equipped computer analysis laboratory represents an $800,000 to $1,000,000 investment. Most LDC's therefore would find use and maintenance of computer image processing costly and difficult to justify in their needs for development.

However, the need for computer technology is often justified. The lack of adequate data interpretation technologies in many LDC's has put them at a disadvantage in dealing with multinational oil and mineral companies interested in developing an LDC's natural resources. Many of these firms maintain well-equipped image analysis laboratories where Landsat scenes of LDC land areas are routinely scrutinized. These companies are then able to negotiate lease rights while possessing better information about the LDC resources than the LDC's themselves. The mistrust generated by this unfortunate situation has led some LDC's to take actions, such as nationalization of the industry, and this benefits neither the country nor the corporations involved. An obvious solution to this situation is to provide the LDC's with the training and equipment that would enable them to carry out their own resource surveys using the latest and best techniques. The LDC's could then share the survey results with private drilling firms in a cooperative project (rather than a confrontational one), thus focusing the firm's efforts on developing the resources (which is their profit incentive anyway). Risks which the firms might feel they are assuming by relying on LDC survey results could be underwritten by an agency already existing in the United States to insure their losses — the Overseas Private Investment Corporation.

Resolution

The final perspective, and the one which has important political implications, is resolution. Spatial resolution defines the ability of a sensor to resolve a surface feature. The higher the resolution (i.e., the smaller the feature one can see on an image), the better one can identify and map natural resources and cultural sites. The first three Landsats had 80-meter resolutions. A fourth Landsat, scheduled to be launched in 1981, will have a 30-meter resolution system (the Thematic Mapper), and France is planning to launch an earth resource satellite with a resolution of 10 meters.

The issue of resolution has important political ramifications. Most countries, including the LDC's, naturally wish to maintain strict control over who photographs their land and for what purpose. While nations are able to restrict the aircraft that fly over their land, the satellite has, of course, circumvented all of these controls. It respects no political boundaries and photographs everything and anything in its orbital path. The subject of what level of resolution civil survey satellites should be allowed to have has been heatedly debated in the United Nations.

The potential use of resource photographs for surveillance purposes has also hampered efforts by the United States and other countries to use satellite technology for the benefit of LDC's. Some LDC's have preferred to classify results derived from satellite imagery and use them to monitor natural resources of their neighbors rather than to manage their own natural resources. Others are hesitant to release high-resolution air photographs that are essential for corrobating satellite imagery data.

While development of high resolution satellites has important political ramifications (since it permits one country to spy on another), the real issue for satellite technology is whether the analysis techniques can handle the additional volume of data associated with the imagery. A factor-of-two increase in resolution means a factor-of-four increase in data, since image data are two-dimensional. If the resolution, the number of spectral bands, and the different gray levels at which data are digitized all double, the informational content goes up by a factor of sixteen. Considering that Landsat users are presently struggling to computer-process the satellite data obtained so far, what will the future hold? One reason that the 80-meter resolution was chosen for the three Landsat satellites was that the resulting degree of blurring was optimal for generating land use maps for national surveys. Higher resolution may mean more detailed information about selected sites, but unless a gross resolution sensor such as that on Landsat is always available, those sites can never be targeted, and the volume of data will preclude national comprehensive surveys. After all, one reason Landsat was used to derive land use and resource maps of California, when we already possessed air photographs of the entire state, was that so many years would elapse in interpreting all of the air photos that an air photo-based map would have been obsolete the day it was completed. The important point is that both gross resolution imagery typical of Landsat and high resolution aerial photography are complementary data sources, of equal importance, for data resource mapping.

International Cooperation

Remote sensing uniquely lends itself to fostering international cooperation. Because satellite images and the ecological problems they pinpoint transcend political boundaries, close coordination between many different nations is essential for applying remote sensing to land management over large areas.

The three agencies most actively involved in using and transferring remote sensing technologies to the developing world for land-use management are A.I.D., the Canadian International Development Agency, and the French *Centre National d'Etudes Spatiales*. All three agencies stress crop surveys and monitoring of desertification, and all three are primarily interested in technology transfer, particularly to LDC's. Recently, several developing countries have also been approached by the Soviets with the offer of assistance in working with Soviet imagery on a bilateral basis. Interest in technology transfer programs has been growing among the LDC's, as they begin to realize the value of remote-sensing data interpretation technologies. LDC host countries have begun to contribute greater amounts of capital, manpower, and equipment to resource development projects than in the past, thus increasing the likelihood of success.

At present, the United States and the Soviet Union are the only two nations involved in obtaining earth resources imagery from space. Flying the MKF-6 (a multispectral, hard film camera) aboard the Soyuz-22, the Soviet Union has obtained excellent quality images of many areas of the world during its manned orbital missions. With resolutions of 25 meters and six spectral bands, the Soviet imagery is

outstanding for monitoring resources and detecting small crop fields. Although dissemination of the imagery was highly restricted in the past, the Soviets have relaxed this policy during the last year and have begun supplying imagery to the United States and other countries on a limited basis.

Several other nations are preparing to launch their own resource satellites. The French are gearing up for the 1983 launch of their SPOT satellite, with a multi-spectral scanner having a resolution of 10 to 20 meters. The Indians, with Soviet assistance, plan to launch a 1-km resolution remote sensing satellite this year as the first step in their space applications program. And the Japanese have plans on the drawing boards for earth resources satellites in the 1980s.

Development of remote sensing capabilities by other countries removes a scientific monopoly (which the United States has possessed in furthering its foreign policy goals) and could also set the stage for increased cooperation among the industrialized countries. With the Americans, Soviets, French, Japanese, and Indians developing satellites of varying orbits, and with sensors of varying resolutions, spectral bands, and targets oriented toward different applications, all this could conceivably provide supplementary data toward a better understanding of our planet's resources. Environmental researchers and resource planners from all nations could have access to these data by means of Intelsat communications satellites.

Can it happen? We hope and think so. The United States, France, and Japan are already discussing this systems approach, at least as far as the space segment is concerned. And the recent release by the Soviets of their satellite imagery can be cautiously but optimistically regarded as a sign of cooperation in international remote sensing of the earth.

Regional remote sensing training centers are being developed in Upper Volta, Kenya and Thailand — centers which have inspired the cooperation of many nations. Vietnam has indicated an interest in remote sensing technology, and China may also begin to participate due to recent political developments. This is only a start toward increased international cooperation, but an encouraging one.

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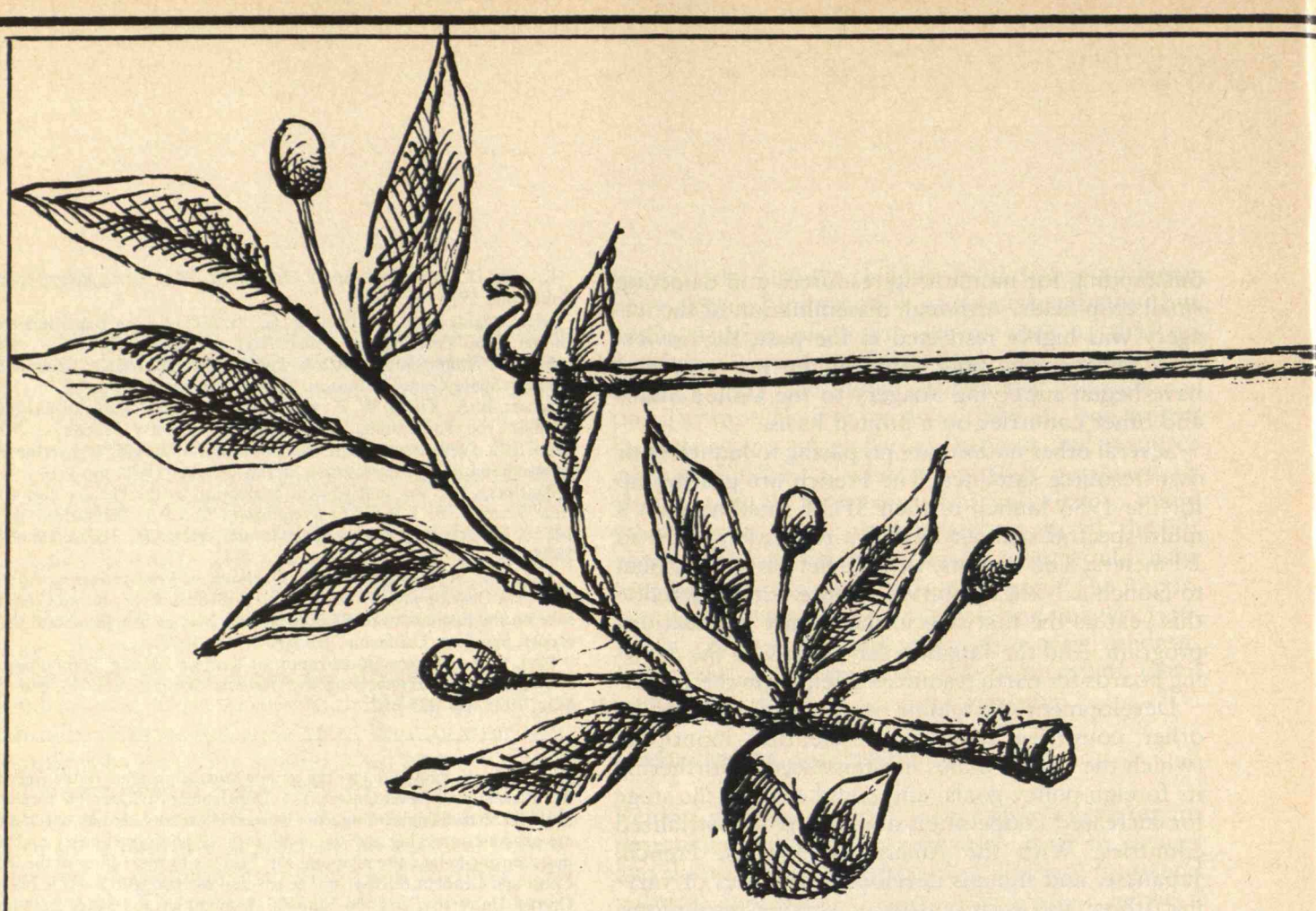

SALT II: Notes on Shadow and Substance

by Howard Margolis and Jack Ruina

It is a mistake to suppose that SALT is a kind of zero sum game, so that if the agreement is good for the Russians it must necessarily be bad for the Americans.

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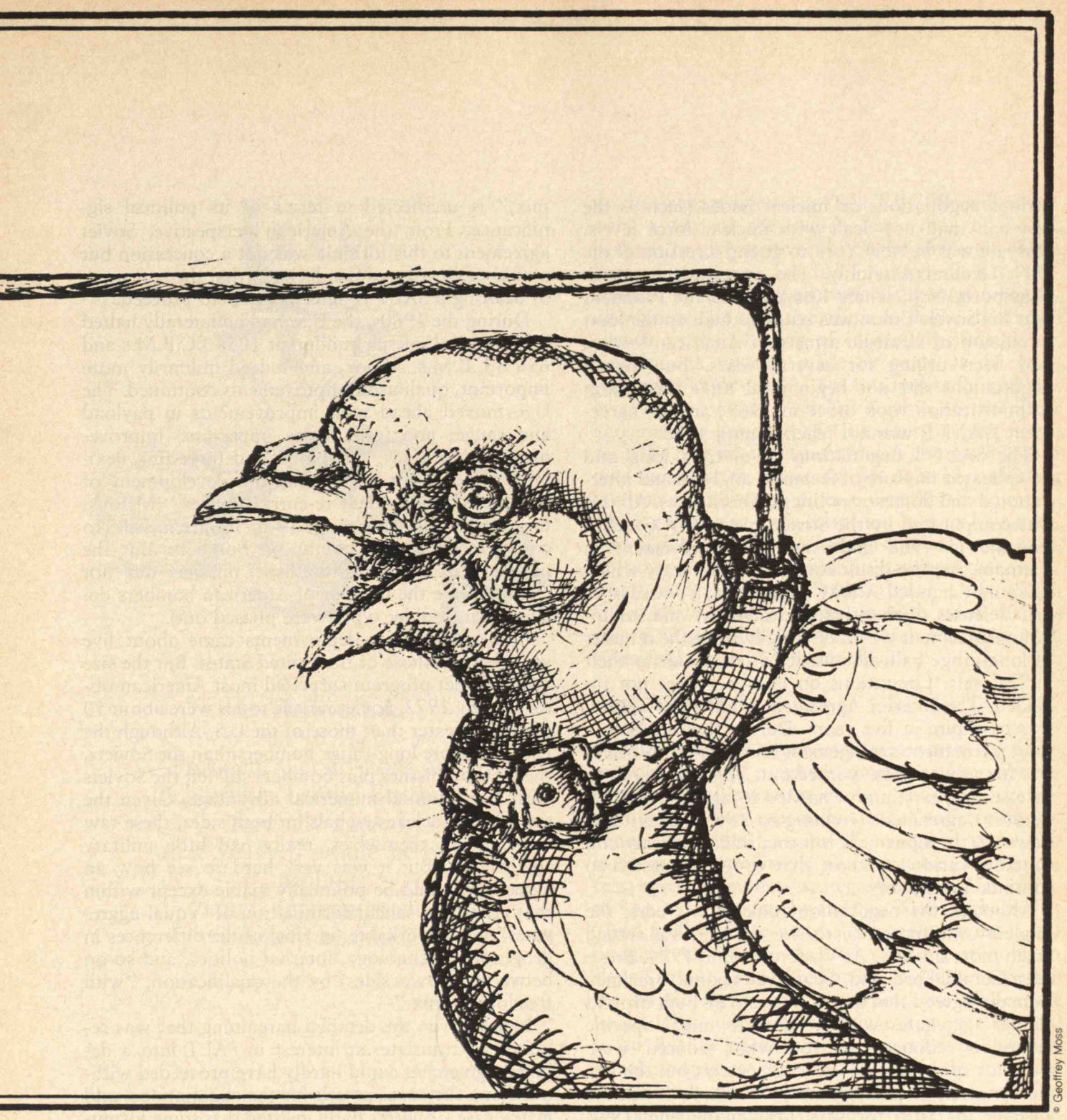

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A rather strong case can be made that the new strategic arms limitation treaty (SALT II) accomplishes almost nothing in terms of effectively limiting strategic arms. There is a puzzle, consequently, over why the treaty should arouse the intensive debate we are witnessing as the Senate hearings proceed. We would not claim it is a terribly deep puzzle. The leading participants in the debate, on both sides, understand well enough what they are arguing about. But it may be useful to lay out a view of this matter for the wider audience which is likely to suppose that since the debate is about the treaty, there must be something about the *substance* of the treaty that really divides the partisans.

A Workable Formula

The origins of SALT date from a hastily arranged meeting between President Lyndon Johnson and Soviet Premier Aleksei Kosygin in 1967. Until then,

serious negotiations on nuclear issues (such as the test ban) had not dealt with nuclear force levels. Kosygin was in New York to attend a session of the U.N. General Assembly. The two leaders met in Glassboro, N.J., where Kosygin told the President that the Soviet Union was ready to take up the joint discussion of strategic arms that American leaders had been urging for several years. But formal negotiations did not begin until after the Nixon Administration took office in 1969; and an agreement (SALT I) was not reached until 1972.

The SALT I negotiations involved a long and complicated mixture of technical analyses and international and domestic politics on both sides. All this was complicated by the Soviet invasion of Czechoslovakia in 1968 and American involvement in Vietnam. But the result consisted of a Treaty which essentially banned A.B.M. (anti-ballistic missiles — i.e., defenses against ballistic missiles) and an Interim Agreement which essentially froze the number of long-range ballistic missiles on each side at their 1972 levels. Limitations on bombers were not included. The Interim Agreement, unlike the Treaty, was to expire in five years. During that interval, a more permanent arrangement with respect to offensive forces was to be worked out. This turned out to take seven years; and it has led to another limited-duration agreement (running to 1985). This time, however, the agreement is formalized as a treaty and contains various features that can be expected to continue indefinitely.

Although the negotiation took seven years, the single most important issue for the U.S. was settled much more quickly. At Vladivostok, in 1974, President Gerald Ford and Chairman Leonid Brezhnev formally agreed that SALT II would be built around "equal aggregates with freedom to mix." Specific numerical ceilings, later somewhat reduced, were also part of the Vladivostok agreement; but the key point was the "equal aggregates" formula. It was the absence of this formula that made the 1972 offensive-force limits an "interim agreement" rather than a treaty. The formula says that each side will be allowed an equal total number of land-based intercontinental ballistic missiles (I.C.B.M.s), submarine launched ballistic missiles (S.L.B.M.s), and strategic bombers. The allocation within the permitted quota of strategic forces among I.C.B.M.s, S.L.B.M.s, and bombers is then left to the discretion of each side. As shown in the table on page 35, there are certain sublimits that qualify the "freedom to mix." But the essential formula, "equal aggregates with freedom to mix," is unaffected in terms of its political significance. From the American perspective, Soviet agreement to this formula was not a concession but a kind of clearing of the decks so that the real work of drafting a SALT II agreement could proceed.

During the 1960s, the U.S. had unilaterally halted its numerical missile buildup at 1054 I.C.B.M.s and 656 S.L.B.M.s. Major, and indeed militarily more important, qualitative improvements continued. The U.S. moved ahead with improvements in payload and range; and (even more important) improvements in accuracy, reliability, and targetting flexibility; and (most important) the development of "multiple, independent re-entry vehicles" (MIRVs) for missiles and short-range air-to-surface missiles to complement gravity bombs on bombers. But the numbers of American ballistic missiles did not change while the number of American bombers declined (since older types were phased out).

Equivalent Soviet deployments came about five years behind those of the United States. But the size of the Soviet program surprised most American observers. By 1972, Soviet missile totals were about 50 per cent greater than those of the U.S. Although the U.S. had more long-range bombers than the Soviets, the total of missiles plus bombers still left the Soviets with a substantial numerical advantage. Given the size of the nuclear arsenals on both sides, these raw numbers, of themselves, really had little military significance. But it was very hard to see how an agreement could be politically viable except within that crude but salient formulation of "equal aggregates" made workable (in view of the differences in geography, technology, internal politics, and so on between the two sides) by the qualification, "with freedom to mix."

Indeed, even the detailed bargaining that was required to translate an interest in SALT into a detailed agreement could hardly have proceeded without some such framework for the negotiations, and in any case Congress flatly insisted that some formulation of equivalence be the basis for SALT II. (Without this "Jackson Amendment," the A.B.M. treaty would hardly have obtained the overwhelming 88-2 vote of approval it finally was given.)

However, the "equal aggregates" formula provided only a framework. Working out the details has been an exceedingly complex process. The SALT II agreement runs to some tens of thousands of words — including not only the elaborately detailed formal treaty but also a variety of supplementary statements, both joint and unilateral, all of which make

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up the package known as "SALT II." We will review only a few of the details here, though enough perhaps to give some sense of the character of the bargaining process. For SALT II, after all, is the outcome of a bargaining process, not the outcome of a disinterested cooperative effort to define the "best" answer to the problem of controlling strategic armaments. A mistake made by some of the more passionate critics of SALT is to suppose that what is involved is a kind of zero sum game, so that if the agreement is good for the Russians, it must necessarily be bad for the Americans. A comparable mistake would be to ignore the presence of conflicting interests. SALT takes place under the shadow of a nuclear threat to both countries, and to humanity, that makes even the most tough-minded recognition of other conflicts of interest between the Soviet Union and the United States appear quite trivial. Given the very large forces on both sides, there is plenty of room for a bargain which will leave both sides, and the world, better off.

Some Rules of the Game

The first question that comes up concerns the effective definition of a strategic weapon. The substantially political character of the "equal aggregates" formula becomes especially clear if you notice that "equal aggregates" essentially means what the two sides, as the outcome of a political bargaining process, agree to count as strategic weapons. U.S. critics of SALT II are upset by the exclusion of the Soviet "Backfire" bomber which (everyone agrees) is not designed for intercontinental missions or now assigned to any such role. For we can observe within the Soviet force structure where the planes are based, what sort of training their crews receive, and so on. But the Backfire nevertheless has potential to attack targets in the U.S. Its exclusion from the Soviet totals must be considered in the context of an overall bargain under which a variety of U.S. and allied forces capable of nuclear attacks on the Soviet Union are not counted in the U.S. aggregate — notably, the Strategic Air Command's FB-111s, U.S. bombers based in England, carrier-based aircraft, and the French and British strategic forces. On the other hand, Soviet missiles targetted on Western Europe are also not included.

A second question, much more fundamental in terms of arms control but much less discussed, concerns what aspects of strategic forces can be controlled. Some things which might be thought impos-

sible to count (by external observation) can in fact be handled, somewhat artificially but effectively, by agreement on detailed "counting rules." The most important of these concerns the limits on MIRV'd missiles. There is no way for a distant observer to know how many warheads a missile may contain. However, it is possible to observe the testing of missiles. The military tradeoffs between number of MIRVs and their accuracy, reliability and so on imply that a well-tested configuration with, say, ten warheads is hardly less valuable than an untested configuration with, say, 20 warheads, necessarily of lower yield. So although the number of MIRVs on a missile cannot be observed, if the two sides agree that any missile which has ever been tested with *n* warheads *counts* as a missile with *n* warheads, then the number of MIRVs is effectively controlled. And in fact that is how the SALT II sublimits on numbers of MIRV'd missiles and numbers of MIRVs per missile, are established.

It is on the question of what can be controlled (i.e., controlled with adequate assurance that violations would be detected) that important changes have taken place in U.S. domestic debates over arms agreements. Verification cannot be discussed today without considering the actual significance of any possible successful evasion, both in terms of the temptation to an evader to try and the concern to a verifier that a try might be made. Moreover, although the kind of verification for which the two sides have adopted formal procedures (e.g., not camouflaging controlled installations) concern "national technical means," everyone understands that neither side is wholly limited to what can be seen from a satellite or openly observed by ground monitoring stations. In other words, there are informers, defectors, and even patriotic citizens who talk too much.

The bargaining process has other significant aspects, but we will only discuss what might be called the "appearances bargaining" aspects of SALT II. Unlike a private agreement between business firms, a treaty — and so highly publicized a treaty as SALT II — is a political document which will be studied for clues on intent, "toughness," and seriousness by the entire range of audiences with whom political players interact.

Consequently, issues arise which have little substance but which nevertheless raise delicate problems for negotiators who have to be concerned not only about substance, but also about how various provisions might be read, or misread, by bureaucratic and political friends and rivals at home and abroad.

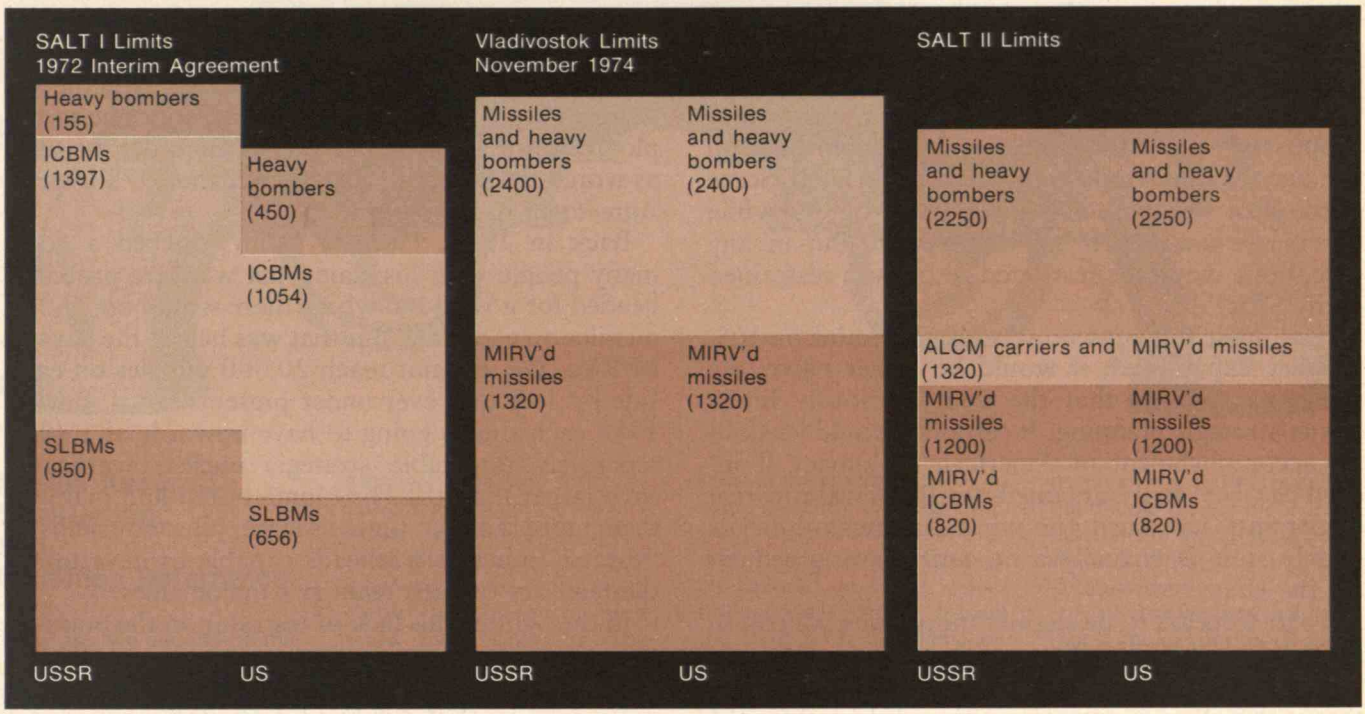
The most interesting example of this type in SALT II concerns the handling of the Soviet SS-18 ballistic missile. This is a new, MIRV'd missile with twice the payload of other missiles being deployed by the Soviets (save the SS9, for which it is a replacement). The United States wanted limits on the payload of missiles; the Soviet Union did not. It is bound to be at least a little misleading to look at the compromise on some *particular* issue, since what the two sides have agreed to is a package which includes a large number of compromises. But with that caution, consider the subdeal on missile size. This limits both sides to new missiles (i.e., replacements for existing I.C.B.M.s, as the U.S. MX will replace Minuteman) of about half the size of the SS-18. The next largest Soviet I.C.B.M., the SS-19, is permitted; and the U.S. MX may be as large as the SS-19 if the U.S. chooses to use the full size allowance. This leaves an asymmetry between the rival forces: the Soviets can keep their extra-large missiles as part of their "equal aggregate"; but since neither side can deploy new missiles of that size, the U.S. is effectively forbidden from replacing 308 of its Minuteman missiles with a missile to match the Soviet SS-18.

But, as far as the strategic balance is concerned, very little is at stake in this asymmetry. The SS-18 is limited to 10 MIRVs, the same number as permitted for a new U.S. missile. Since the military capability of these weapons depends primarily on their reliability, targetting flexibility, and accuracy — rather than on payload — the military significance of the extra Soviet throw-weight of the SS-18s is not great. That is why there has been no serious U.S. interest in building an I.C.B.M. as large as the SS-18 whether or not the treaty permitted it. Further, though we know little about internal Soviet deliberations on SALT, we can assume that a lot of U.S. concessions on other points would be necessary to persuade the Soviets to agree to retire the SS-18s when they had only so recently spent some billions of rubles developing and deploying the system.

Finally, if the U.S. insisted on the right to build a weapon the size of the SS-18, it would be immediately pointed out by critics of SALT that the nominal symmetry was worthless, since the U.S. neither intended to, nor as a practical matter could, deploy such a weapon within the time frame of SALT II.

In sum, it would certainly have cost more than it was worth in terms of concessions elsewhere (were it

Agreed Strategic Force Limits



feasible at all) to get the Soviets to dismantle their SS-18s. Giving up the U.S. right to build an equivalent weapon was giving up nothing the U.S. was considering anyway. As a bargaining outcome, it is not surprising that something which the Soviets could not easily give up (the newly deployed SS-18s) was not nearly as important to the U.S. as Soviet concessions on other matters. Among concessions substantially more important to the United States were: permitted range of cruise missiles; number of MIRV's per missile; and steps to make verification (and, inescapably, intelligence-gathering in general) easier for the U.S. Further, it is not surprising that the ban on future deployment of SS-18-size missiles by the Soviet Union is written in a way which also bans a U.S. deployment to match the SS-18. The U.S. constraint is apparently something the Soviets value and which costs the U.S. nothing. For no matter how the wording went, the number of SS-18-size missiles the United States planned to build is the same: zero.

But as a matter of domestic politics, the issue has been a lively one in the U.S. In fact the SS-18 asymmetry has provoked more controversy than any other provision of SALT II. This suggests that, if the SS-18 issue is the hottest substantive issue in SALT II, there must be a shortage of substantive things to argue about.

Overall, the bargain struck at SALT II looks reasonable. In this context, it is quite implausible to suppose that after seven years of negotiation the Soviets would accept unilateral rewriting of the treaty (as proposed by some Senate critics). Certainly if the Soviets attempted any such unilateral rewriting, we would reject it out of hand. Who could afford to accept such a precedent?

Nevertheless, we expect there will be an equivalent of the "Jackson Amendment" associated with SALT II to express Congressional views on the conduct of SALT III negotiations (as the original Jackson Amendment was an instruction on what Congress expected in SALT II); and clarifications of language which do not require renewed negotiations with the Soviets.

Limited Limitations

In October, 1978, the Committee on the Present Danger, which includes most of the more prominent and influential critics of the treaty, provided a list of "urgent needs" for the U.S. strategic forces. It comprised an ambitious program, calling for further efforts to upgrade all three elements of the American strategic "triad" (land-based missiles, sea-based missiles, and manned bombers); vigorous research on ballistic missile defense; a new commitment to bomber defense; "re-examination" of the present lackadaisical civil defense program; and strong ef-

forts to further improve the capability for detailed central command and control of strategic forces in the event of war. As has been pointed out by supporters of SALT II, whatever the merits of these various proposals — and they vary — there is nothing on this agenda that would be affected by SALT II. Some of the efforts proposed are already in progress; while others are under active consideration. But in any case, none would be restricted — or even restrained — by SALT II.

But if SALT II puts no serious constraint on U.S. military capabilities, it would be rather naive, we think, to suppose that the treaty seriously limits Soviet strategic planning. It certainly would be skillful accomplishment of American diplomacy if indeed the U.S. had bargained the Russians into real constraints in return for what American officials openly state is virtually a no-constraint agreement for the U.S.

There appears to be slightly more arms control in the agreement for the Russians than for the U.S., but this is perhaps true only if we neglect the possibility that some Soviet interests expressed during the negotiations reflected bargaining tactics. The Russians will have to dismantle some 270 strategic systems by 1985. The limit on MIRV missiles falls several hundred below the number advocated by the Russians during the negotiations. The same holds true with respect to the total number of strategic delivery vehicles (the missiles and bombers counted in the "equal aggregates").

However, the agreed-upon number of MIRV'd missiles and the number of separately targetable warheads is very much higher than existing Soviet (and substantially higher than existing U.S.) numbers. Though the number of missile launchers will now decrease, the agreement allows the Soviets to continue the rapid upgrading of their I.C.B.M. force that has continued surprisingly largely unabated since the mid-1960s. We must expect the dismantling of several hundred of their oldest I.C.B.M.s to be accompanied by increased capabilities of the 1200 which SALT permits. Overall, there seems to be no reason to believe that the Soviets feel notably more restrained by SALT II than the U.S. — which is to say, virtually not at all. They will have ample outlets for whatever resources they care to devote to further strengthening of their strategic forces; and on the record of the past dozen years, we have little reason to expect to see restraint.

The Carter Administration naturally emphasizes the more affirmative aspect, which is that if we extrapolate current Soviet I.C.B.M. building rates, then SALT II could be read as substantially curtailing the Soviet program. This supposes that in the absence of SALT II, the Soviets would continue to deploy new missiles but cease to retire older missiles, as would be perfectly "legal" since the 1972 Interim Agreement has expired.

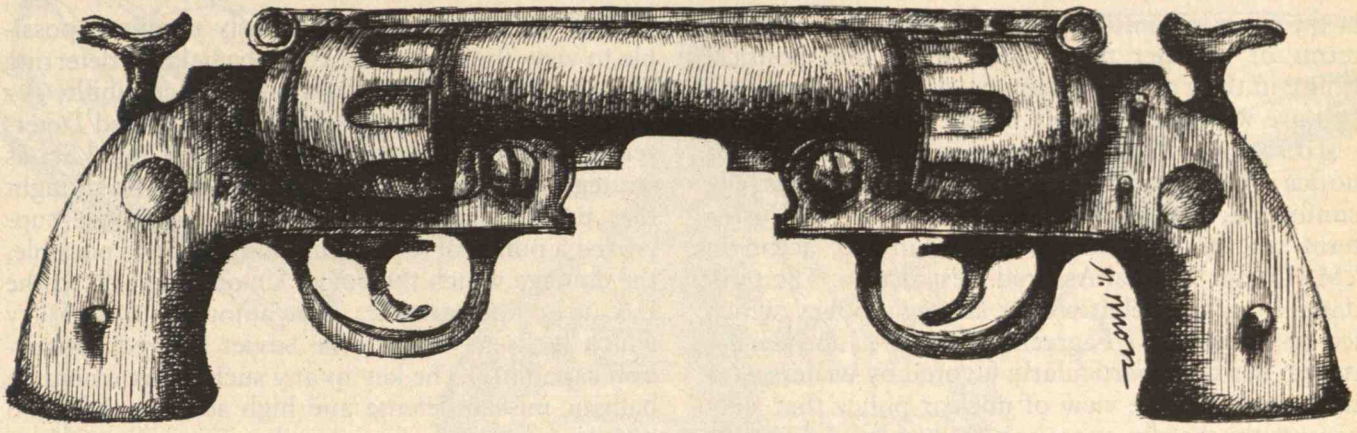
Back in 1960, Herman Kahn shocked a good many people with his claim that we were probably headed for a world in which there would be 20,000 missiles on each side. But that was before the days of MIRVs. We will not reach 20,000 missiles on each side by 1980, or ever under present trends. But by 1985 each side is going to have upwards of 10,000 separately targetable strategic nuclear warheads, each larger than the Hiroshima bomb and many of them more than ten times as large, plus thousands of "theatre" nuclear warheads capable of devastating the territory of each country's major allies.

In the light of this lack of restraint on the building of nuclear forces — and where, even with SALT, energetic programs on both sides continue — it is not surprising that ardent advocates of arms control are among those most concerned about SALT II and the whole SALT process. Unfortunately, it does not require incorrigible cynicism to see the SALT process as consisting of the hard-liners on both sides agreeing to forego what they do not much want to do anyway at the price of exacting commitments of support for those things which they do want to do. If that is all SALT is accomplishing, then it is only the advocates of restraints on nuclear forces who are being disarmed.

A more elaborate version of the argument that SALT disarms the arms controllers more than the military planners takes account both of the bargaining leverage that military planners obtain (as the price of agreeing to the constraints they find least burdensome, and of the displacement within SALT of the arms momentum into areas that might otherwise receive less emphasis.

A MAD World

The most fundamental requirement of American nuclear policy has been the capability, even in the face of an all-out surprise attack, to retaliate with sufficiently awesome force to make any such attack utterly irrational. This basic deterrent has been defined in various ways, most recently as the capability to destroy the 200 largest cities in the Soviet Union following an all-out surprise attack on U.S.



Mutual Assured Destruction and Extended Deterrence

There are two distinguishable policy dimensions. The first deals with the extent to which nuclear weapons should be judged to have a measure of political utility. Along this political dimension, nuclear forces are viewed at one extreme as much too dangerous to be considered an instrument of policy in anything but the negative sense of deterring their plausible first use by the other side; and at the other extreme as credibly usable to fight wars and project power. The position we have labelled "Extended Deterrence" sees nuclear capabilities as indeed having some utility as a deterrent to aggressive behavior short of nuclear aggression. This is a rather metaphysical proposition, since it is hardly clear what proponents of Extended Deterrence have in mind when they speak, as they sometimes do, of the significance of details of the nuclear balance to such matters as Soviet support of revolution in Angola. On the other hand, since it is hard to understand how governments are led to the choices they make — just why the Soviets came to judge it sensible to put missiles in Cuba, or the U.S. to put 500,000 troops into Vietnam — one cannot rule out the possibility that in subtle but not insignificant ways, nuclear capabilities can be given political utility.

The second dimension deals with the problem of what should be done with respect to the possibility that, in some presently unimaginable way, deterrence fails. To what extent should planning be tailored to build capabilities that might lessen the extent of the damage? After all, 100 million dead is worse that 10 million dead. On the other hand, what is "damage-limiting" for one side will look like an effort to undermine confidence in basic deterrence for the other side, generating a countervailing effort. So the issue is not whether less damage is better than more; but whether the pursuit of less damage is likely to lead to less damage.

In these terms, MAD is a policy favoring the acceptance of mutual vulnerability as most likely to encourage the withholding of forces in the most demanding contingency. Extended Deterrence is a policy towards the middle (rarely more than that) of the spectrum of possibilities along our political utility dimension.

Note that we have not said that a choice on one element of policy can be made independent of choice with respect to the other. The extent to which that is so, or might be made so by suitable force design, is itself at very nearly the heart of the overall strategic debate. We are merely saying that the two aspects of strategic policy are conceptually separable; so assuming that the choice is always between MAD and Extended Deterrence seriously oversimplifies the strategic debate and leads to a misunderstanding of the position of many participants in the argument. — *H.M. and J.R.* □

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forces. How American forces would actually be used in the event of a nuclear war is another matter. But American policy has always been emphatic that a capability for overwhelming retaliation must exist. The strategic community has given various technocratic names to this capability — for example, "Type 1 deterrence." But Secretaries of Defense have followed Robert S. McNamara in talking about "assured destruction," which has the virtue that on a matter where euphemism may be dangerous rather than polite, the words convey an unmistakable sense of what is at stake.

It has also been clear for many years that the Soviet Union has, and is able and determined to maintain, a comparable assured-destruction capability. Mutuality of assured destruction is a direct consequence of the low cost and great destructive power of nuclear weapons. It is simply a fact of life. No one taken seriously in the debate over SALT would care to argue, for either the U.S. or the Soviet Union, that all-out nuclear war could be considered a rational instrument of policy in any contingency, however desperate. But questions still remain on whether, and if so how, the potential use of nuclear weapons might have political utility: influencing the expectations and behavior of friends, or rivals, or

both. Most commonly, the argument is framed in terms of whether the Soviets might find political utility in their nuclear weapons, and what American posture would adequately negate that possibility.

To see how the argument goes, it is important to notice two contrasting, though not necessarily conflicting, themes. For one of these, we will use a term we do not like, the now-familiar acronym "MAD" for Mutual Assured Destruction. The term dates from the debates over strategic policy which led up to the SALT I agreement in 1972, and the acronym has been particularly favored by writers who wish to attack the view of nuclear policy that fully accepts this hardly appealing kind of mutuality. It is tempting to pick an equally appropriate term for the other viewpoint with particular appeal for those most antipathetic to MAD: for example, NUT, or Nuclear Utilization Theory. However, we will use a more neutral term, "Extended Deterrence." We think of MAD vs. Extended Deterrence not as a dichotomy, or even as the opposite poles of a spectrum, but as a pair of policy dimensions. One concerns the very fabric of Soviet or U.S. society; the other concerns political/military objectives beyond efforts to reduce or control the risk nuclear warfare poses for civil society (*see box on previous page*).

It is worth noting that both notions first began to exercise an influence on U.S. policy through the agency of the same individual and at essentially the same time. In 1962, Secretary of Defense McNamara suggested that an increase in the stability of the "balance of terror" might be served by the achievement of a secure nuclear force by the Soviet Union as well as the U.S. (the essence of the MAD position); *and* that the U.S. should develop capabilities and doctrine for "flexible and controlled" use of strategic nuclear forces. Although McNamara simultaneously put great stress on the capabilities for non-nuclear responses to non-nuclear aggression, his argument was at least open to this interpretation: if all-out nuclear war had become politically incredible, then perhaps extended deterrence against non-nuclear aggression could be sustained (made "not incredible") by a doctrine that stressed limited use against military targets only (i.e., avoiding cities).

So with respect to reducing the risk of the ultimate disaster, what began to be discussed was the possibility that everyone might be somewhat safer in a world in which secure "assured destruction" forces existed on both sides, so that even in the worst crisis it would be politically irrational to resort to all-out nuclear war. But it simultaneously remained possible to view the very stability of the balance deterring all-out nuclear war as sustaining the credibility (or at least the "not-incredibility") of Extended Deterrence. A twin debate developed in the United States strategic community. There were those who thought that prudence and subtle political advantage supported a policy of seeking to limit, as far as possible, the damage which the Soviet Union might do to the U.S. in a nuclear war. This amounts to a policy which seeks to weaken the Soviet assured destruction capability. The key to any such effort would be ballistic missile defense and high accuracy MIRV'd missiles to attack Soviet military targets. Others thought this futile, and indeed, self-defeating. At the same time, there was an argument about the credibility, and the usefulness of a residual threat, of limited nuclear war. This was based on the notion of "flexible and controlled" use of nuclear weapons.

There never was, and still is not, a clear resolution of these issues. The significance of "what if . . ." scenarios for affecting the perceptions and, at least in subtle ways, behavior of adversaries and allies remains a question which by its nature provides no definite resolution.

But the trend of American policy across the decade of the 1960s was towards acceptance of MAD as less bad than other feasible alternatives; at the same time there was wavering but generally diminishing emphasis on Extended Deterrence.

The climactic event of this evolution was the signing of the SALT I agreement near the end of the first Nixon Administration. The evolution reflects (in a mixture of motives which even those responsible would probably find difficult to sort out) the realities of feasible capabilities on both sides of the U.S.-Soviet nuclear balance; and the easing of international tensions (détente), starting particularly with the Limited Test Ban Treaty in 1963. Naturally, these elements were intimately linked. The decisive step was the agreement in SALT I for the U.S. and Soviet Union to forego any serious attempt to provide active defenses of their societies against ballistic missiles.

SALT II confirms and reinforces the tendencies of SALT I. The debate over SALT II reflects the concerns of those who feel that the U.S. has drifted too far (either in an absolute sense, or relative to the Soviets, or both) toward accepting the supposition that the details of the U.S.-Soviet nuclear balance are no longer significant in global politics as long as both countries have such large and survivable forces.

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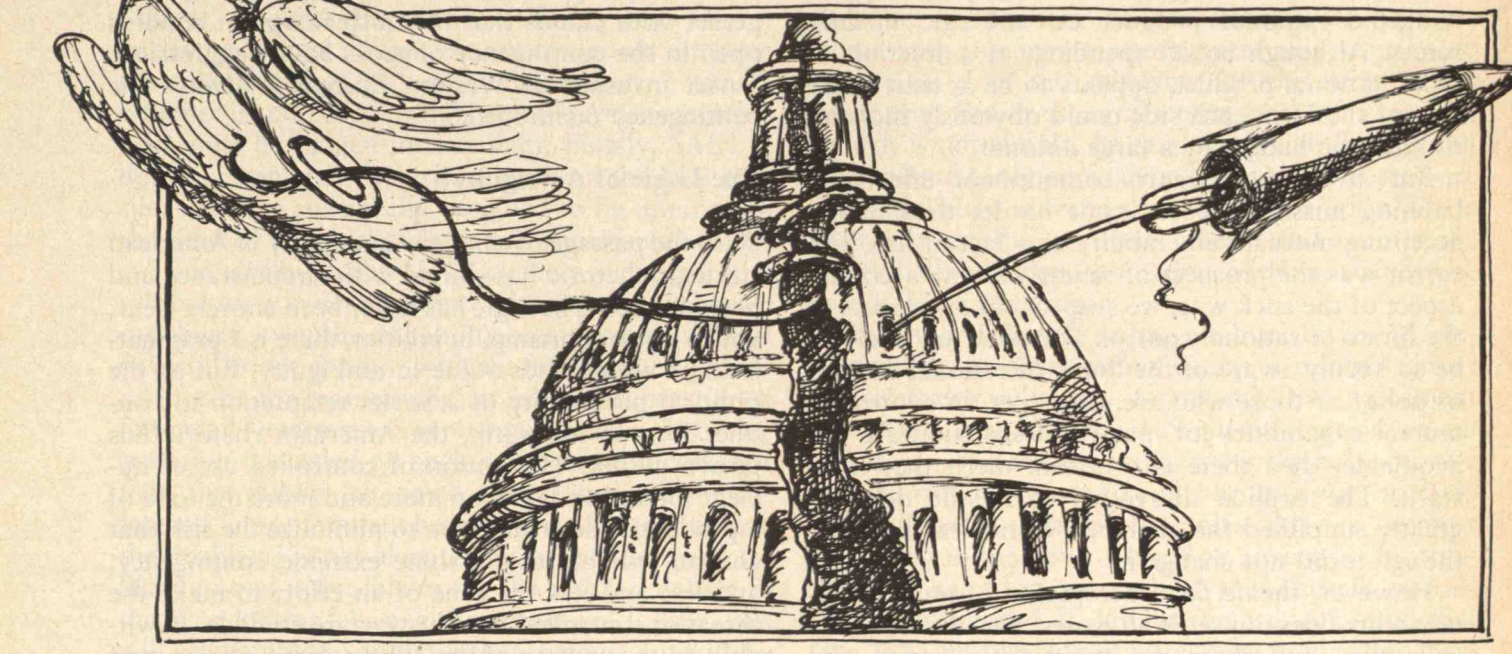


The essential points to understand about MAD concern the alternatives to MAD. There are essentially only two:

☐ *Nuclear disarmament.* A workable scheme for complete nuclear disarmament would not be easy to design, even if both sides were ready to consider so dramatic a step. The effect on Nth country ambitions and temptations would not necessarily be benign. The problems of verification would be enormous, since the scale of militarily significant clandestine armament would be minute compared to a situation in which both sides remain heavily armed. Finally, no one has any idea of how the capability to re-arm, and the temptation to do so in a severe crisis, could be restrained. So quite aside from questions of political feasibility, it is not obvious at all that nuclear disarmament would lead to a military balance which is more stable, or to greater ultimate security, than a MAD world. This is not to doubt that large reductions from current force levels could be reached before any of the problems of total nuclear disarmament became severe. But we would still be in a MAD world.

☐ *Damage-limiting.* Each side could attempt — through ballistic missile and air defenses, civil defense, and through construction of offensive forces aimed at destroying enemy missiles before they could be launched — to limit the ability of the other side to inflict civil damage on one's own society. But technical realities do not favor such efforts. It is far easier to protect missiles than to protect cities; missiles can be buried, dispersed, made mobile, even actively defended, with a combination of confidence and relative economy that cannot be approached by efforts to protect civil society. And if, in addition, there is no effective defense against a missile force once launched, the best prospect for "using" one's own forces to reduce civil damage in the event of war is to *withhold* the forces in hope that this will deter the adversary from using his. That is why the SALT I agreement implies more than a verbal disavowal of serious efforts at damage limiting. Without missile defense, the physical capability is effectively denied.

An Acceptance of Mutual Vulnerability

The decision by both sides to halt their initial deployments of ballistic missile defenses is something that seems to have had no parallel in human history. To abandon the effort to build a shield against a fatal threat does not come easily to people or to nations. This probably required both a pessimistic (realistic, we would say) judgment about the prospect that necessarily untried missile defenses would actually perform as designed, together with a pessimistic (and again realistic) assessment of the likely response of the other side to any effort which could be interpreted as threatening its assured-destruction capability. The U.S. spends about 1/2 of 1 per cent of

its gross national product on strategic nuclear forces. Although Soviet spending, as a fraction of gross national product, appears to be at least twice that of the U.S., each side could obviously increase its strategic budget by a large amount.

But an explicit treaty commitment effectively banning missile defenses came harder than tacitly accepting mutual vulnerability as a fact of life. The carrot was the prospect of saving money; a critical aspect of the stick was, we suspect, an awareness of the limits of rational control. For none are likely to be so keenly aware of the limits of rational control of policy as those who are, on paper, in control. If mutual capabilities for massive destruction are unavoidable, then there is a certain merit that it be stark. The explicit disavowal of missile defenses greatly simplified the character of nuclear balance, though it did not change it.

However, the *de facto* acceptance of mutual vulnerability does not settle all issues. Nuclear weapons still exist, and there are enormously varied and still-developing capabilities for using them. It is possible that some might go off, whether by intent or miscalculation or accident, whether through an act of one of the superpowers or that of an Nth country. Further, even within the framework of MAD, what the Soviet Union and the U.S. do with respect to nuclear weapons could have political consequences even though the weapons are never used. It is worth reiterating that the original context — in which McNamara first broached the idea that came to mean mutual assured destruction — was closely connected with U.S. interest in extending the political/military utility of strategic forces. The issue arose in the context of assuring our N.A.T.O. allies that the U.S. nuclear umbrella could remain a credible deterrent to Soviet threats to Europe even when the Soviets were capable of devastating the U.S. In short, in its first statements, MAD was closely associated with Extended Deterrence. The suggestion that, in the context of mutual deterrence, each side would adopt a "no-cities" counterforce strategy was heatedly denounced by the Soviets (and others) as a proposal for making the world safe for nuclear war. McNamara himself quickly began to qualify his suggestion, and U.S. policy statements ever since have provided a tantalizing mixture of warnings: on one hand, about the danger of supposing that nuclear weapons could be used in a militarily meaningful way without risking escalation to large scale nuclear destruction; and, on the other hand, about flexible and controlled use of nuclear weapons, together with claims that the nuclear option remains open in the contingency of gross Soviet aggression. Soviet invasion of Western Europe is always the contingency mentioned.

The Logic of Ambiguity

With the passage of time, the ambiguity in American strategic rhetoric has shifted with circumstance and personalities. The logic has never been entirely clear, which is not suprising. In politics, there is a pragmatic logic which finds value in ambiguity. But as the political plausibility of a Soviet temptation to conquer Europe has sunk, the American rhetoric has grown milder. The notion of controlled use of nuclear forces has taken on more and more the tone of a prudential determination to minimize the risk that control will be lost in some extreme contingency, and less and less the tone of an effort to make the threat of controlled nuclear warfare credible. Inevitably, in the context of this subtly shifting balance of ambiguities (conveyed by budget and deployment decisions as well as by rhetoric), there will be some who think that U.S. policy has shifted too slowly toward treating nuclear weapons more as a problem of survival that must be managed rather than as a significant lever on international politics. Others think the shift has been too fast and ill-considered.

Since the stakes are large, even subtle shifts can be taken seriously by people who have devoted their lives to problems of national security. Although the substantive issues are nuclear policies, the nature of politics puts a premium on arguments that are effective and not necessarily on those which would win the admiration of an observer watching from Olympus. Politics makes strange bedfellows, and it also makes strange arguments. That has something to do with why so much is heard about SALT II's denial of an American option to build a heavy I.C.B.M. that essentially no one on the American side is interested in building.

For many critics of SALT, the SS-18 has become a symbol of a particular concern with the growing number of accurate Soviet warheads which threaten the U.S. Minuteman I.C.B.M. force. Now even in the worst case, this threat does not jeopardize the American retaliatory capability, since neither alert bombers nor S.L.B.M.s (which together hold the bulk of the American strategic capability) are at risk; and it is not clear how the hypothesized Soviet destruction of our I.C.B.M. warheads would imply meaningful military or political advantage. This

"threat" assumes that the Soviet forces work almost perfectly. Several million Americans would die from the side effects of such a "purely military" attack, whether it succeeded or not, and the American reaction must be judged in that light. Finally, SALT II does not constrain American work on the MX missile, which is specifically designed to be immune to the kind of attack that threatens Minuteman.

Thus, although the SS-18 concern seems to be a symbol for a wider concern with the Soviet I.C.B.M. capability, even this capability seems to be a symbol of a still wider concern with the adequacy of American forces for maintaining an adequate measure of Extended Deterrence. Suppose you believe that more attention is needed on such strategic problems, but that the public (to some extent because misinformed, to some extent because it is reluctant to face the problem) is not alert to the issue. Then you are likely to find it sensible to use the SALT II debate as the occasion for focusing that attention. Indeed, you will be tempted to suppose that, were it not for the lulling effect of SALT, Americans would be more ready to face the problem.

Naturally, the situation is complicated by what the Soviets are saying and doing. The internal politics on the Soviet side also comprise a spectrum of views — probably more nearly akin to those on the American side than to those of a coldly calculating and aggressive monolith named Moscow.

The Value of SALT

If you turn around the argument we have used to describe American tendencies, you have what may be a reasonable approximation of Soviet tendencies. As the U.S. is not prepared to flatly disavow a threat to use nuclear weapons in an extreme contingency, the Soviets are not prepared to disavow the threat to make any nuclear war an all-out fight to the finish. The tendencies reinforce each other. For the more threatening each side seems to the other, the more the other side sees a need to demonstrate that it is not intimidated. A good part of the value of SALT is as an elaborate, excruciatingly cautious ceremony in which the two superpowers back away from the ultimate confrontation. It may seem a small step for the two sides to formally agree not to do some things which neither is anxious to do; but each side can feel a little relieved that what probably would not be done will definitely not be done.

The careful arrangements for verification, the painstakingly developed pattern of negotiation (trading off an item the Americans want here for something the Soviets want there) may seem more elaborate than the substance of the achievement warrants. But it is an essential part of a process which is not simple, or easy, or trivial. Further, all sets of militarily-equivalent balances of forces are not equivalent in terms of stability in a crisis. There certainly are things to talk about, and even in the face of all the difficulties, there are things that can be profitably agreed upon.

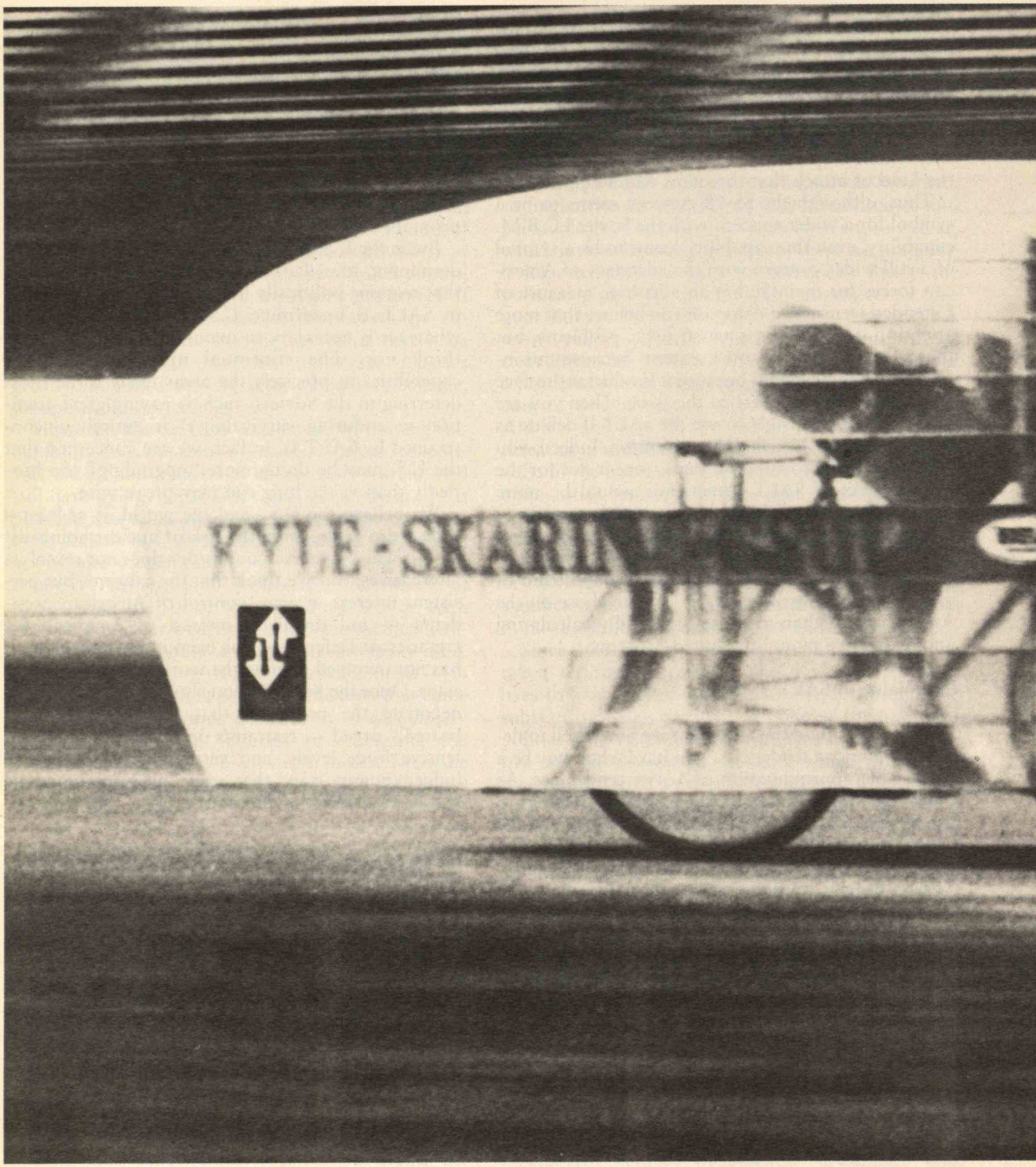
But is the U.S. proceeding too fast? Is the U.S. undermining, to a dangerous extent, a residual threat that remains politically important? Does agreement in SALT II undermine U.S. determination to do whatever is necessary to maintain the balance? We think not. The continual upgrading of U.S. capabilities in precisely the areas likely to be most deterring to the Soviets (such as paying great attention to enduring survivability) is entirely unconstrained by SALT II. In fact, we are concerned that the U.S. may be doing more "upgrading" too hurriedly than in the long run may prove wise.

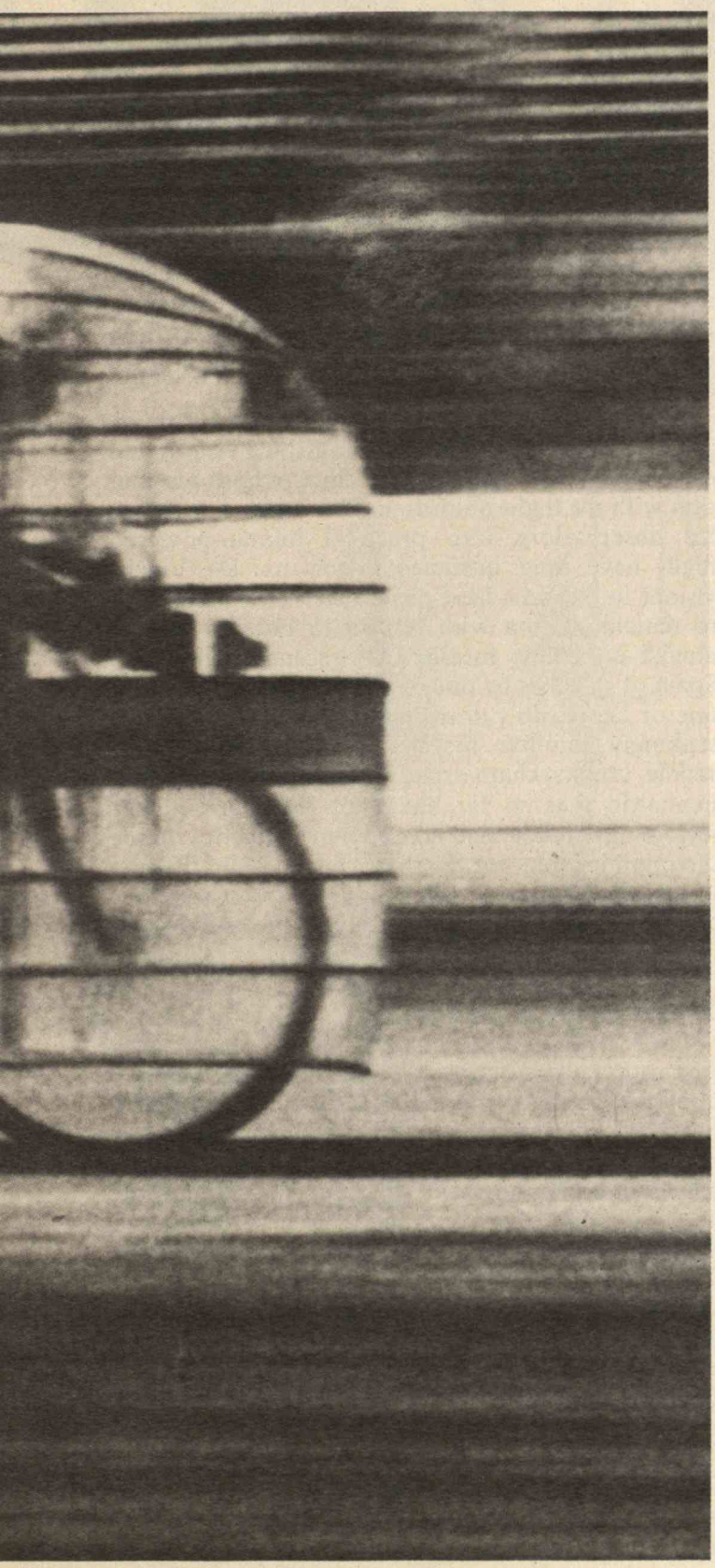
We believe the U.S., and the world, is at least a little more secure from the risk of nuclear holocaust than it was 20 years ago. History does not reveal its alternatives. But we think that the cautious but persistent interest in arms control of American presidents — and the lively interest of American Secretaries of Defense — has been important. And, it has not involved turning the world over to the Russians. Once the Soviet Union showed it was ready to negotiate the proposals that Americans had repeatedly urged — restraints on missile defenses, offensive force levels, and verification — can it be judged unimportant that some progress could be made? Consider the alternative.

Howard Margolis is a research fellow at the M.I.T. Center for International Studies, where he shares responsibility for the Program on International Environmental Issues. He has been actively involved in defense matters, and during the early 1960s was on the staff of the Secretary of Defense.

Jack Ruina is professor of electrical engineering at M.I.T., and directs the M.I.T. Arms Control and Defense Policy Program at the Center for International Studies. He has served as a member of the General Advisory Committee of the Arms Control and Disarmament Agency, as president of the Institute for Defense Analyses, and as director of the Defense Department's Advanced Research Projects Agency.

Streamlined bicycle designed by Professor Chester Kyle of the California State University at Long Beach. During the 1979 International Human-Powered Speed Championship race, champion cyclist Ron Skarin rode it 31.88 miles in one hour. (Photo: Chester Kyle)





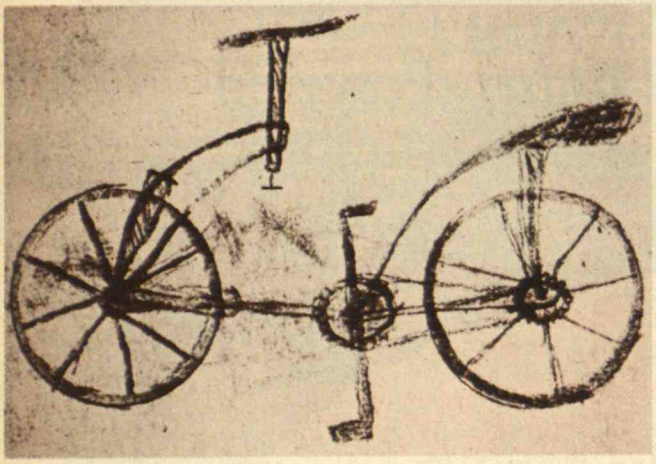
Getting in Gear: Human-Powered Transportation

by David Gordon Wilson

Current and near-future development of human-powered vehicles could lead to their much wider everyday use, to the ultimate benefit of our energy-intensive nation and world.

It is frequently claimed that 70 to 100 million Americans own bicycles, most of which are relegated to garage and basement. But the rising price and occasional scarcity of motor fuels have led to an increasing number being used for both transportation and recreation, a harbinger perhaps of a substantive trend toward social acceptance of this energy-saving means of transportation. (When I first bicycled on this side of the Atlantic in 1953, an adult bicyclist was regarded as a very queer fish indeed.)

During the coming years we can expect the technology of bicycles and other human-powered vehicles (HPVs) to improve rapidly. (Walking, running, and swimming are human-powered means of movement; therefore we must specifically define human-powered transportation [HPT] as encompassing those modes of getting from here to there with vehicles or mechanical aids.) Such development will help to increase general public participation in all HPT areas: on land, for short-distance travel (at least partly because the health benefits of regular daily exercise are becoming more clearly recognized); in the air and on water, almost entirely for recreational and sport use.



Top: The bicycle as envisioned by a pupil of Leonardo da Vinci. The sketch, hidden on the back of a page from the *Codex Atlanticus*, was, until recently, unseen since the 1490s.

Middle: A hobby horse of the early 19th century. (Smithsonian Institute)

Bottom: "Denis Johnson's Pedestrian Hobby Horse Riding School in London," an 1819 aquatint by H. Alken. (Smithsonian Institution)

The Dawn of Human-Powered Transportation

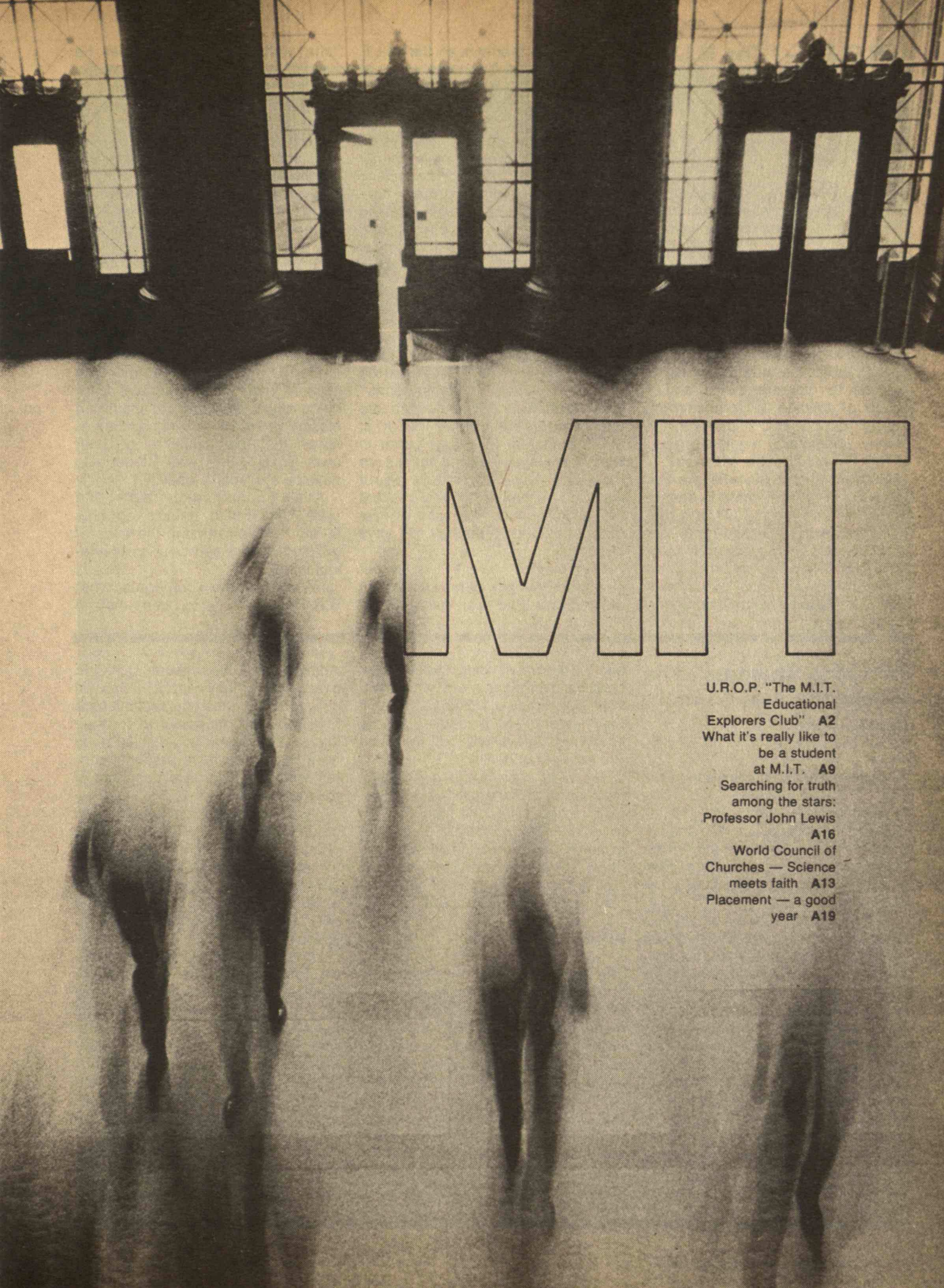
Humans probably used crude oars to propel boats even before the invention of the wheel made possible carts for animal- and human-powered haulage. Virgil vividly describes a boat race in which the crews used oars at the games arranged by Aeneas for his father's funeral. The earliest that we know of human-powered mechanical aids to moving on land is the use of crude ice skates made of sharpened bone in Sweden in the eighth century. Stilts may have been used earlier. Roller skates and the like (skate boards, for example) came along much later.

But the modern history of human-powered transportation must start with the astonishing visions and experiments of Leonardo da Vinci, whose fascination with the flight of birds and attempts to translate his observations into practical human-powered flight have long intrigued historians. Da Vinci's visions in this area have proved sterile and are likely to remain so, but with respect to bicycles he had almost incredible foresight. A recent discovery in Spain of sketches by one of his pupils on the back of one of Leonardo's drawings of the 1490s shows a strikingly familiar bicycle design complete with saddle, cranks, chain drive, and step-up gearing. But Leonardo was so far ahead of then-current HPT technology that he had no apparent influence on the direction it took: not for three centuries did the first known two-wheeled vehicle appear, and it was four centuries before the chain-driven bicycle as we know it today was developed.

The Flowering of the Bicycle

The roots of the bicycle are in an 18th-century toy upon which children would gallop — a stick with a horse's head at one end and, sometimes, a wheel at the other. Around 1790 someone put a nonsteerable wheel under the head end of the stick, and a saddle in the middle to make an adult version of the toy. This dandy, or hobby, horse was a significant aid to fast walking or running, but the weight of these devices, the absence of resilient tires, the high-friction bearings, and the atrocious roads must have restricted their use to the dedicated and the masochistic.

The Baron Karl von Drais, a German agricultural engineer, was impressed with the potential of a two-wheeled vehicle to traverse forest land for which he had responsibility and started serious development in 1817 by making the front wheel steer-



MIT

U.R.O.P. — "The M.I.T. Educational Explorers' Club"

by Beth Marcus, '79

What is U.R.O.P.? It's brain science and performing arts and everything in between. It's anything the mind of an M.I.T. student could want to explore.

I've been involved in U.R.O.P. (Undergraduate Research Opportunities Program) since my freshman year and have participated in three unrelated projects. U.R.O.P. has done a lot for me in terms of exposing me to different things and in terms of helping to formulate my career goals. But I didn't really clearly understand my ideas about U.R.O.P. until about a year ago.

Gregory Smith, '30, who works in the U.R.O.P. office, came to see me on a "site visit" at my U.R.O.P. project; his questions helped me to see what my U.R.O.P. experience really meant. So when *Technology Review* asked me to describe and explain U.R.O.P., I went back to Greg Smith.

Greg is a member of the M.I.T. Corporation and has been a volunteer with U.R.O.P. since he retired from industry in 1972, three years after the program began. At the time Professor Margaret L. A. MacVicar, U.R.O.P. director, was trying to get more medical projects for students to work on. Mr. Smith had many contacts in the Boston medical world, so he undertook the task of expanding medical U.R.O.P. At first, he recalls, many doctors he interviewed were hesitant to take M.I.T. students into research projects which had traditionally been done by students from Harvard Medical School. But many were willing to give M.I.T. students a chance. After six years the results have been "sensational," says Greg Smith. The doctors are unanimously enthusiastic about it: M.I.T. students, they say, come in without any preconceived notions, so they ask naive questions about medicine — they ask "questions that the doctors never thought of, yet really should have thought of," says Mr. Smith.

After medical U.R.O.P. really got going, Greg Smith, at the suggestion of Professor MacVicar, began doing "site visits," and that's what he spends most of his time on now. On a "site visit," Mr. Smith explains, "I visit the students at their projects, not really as a detective, but to see if they really like the projects, if — in our judgment — the projects are worthwhile, and most importantly to find out what the impact of the program has been on the students — on their education and on their philosophy and goals.

"If you read Edwin Land's Arthur D. Little Lecture, the famous speech that pointed out the need for something like U.R.O.P., you see that he contended that the undergraduate mind was not having its creativity developed," says Mr. Smith. One reason was that "students were doing routine, pretty much spoon-fed classroom work. Dr. Land maintained that they could be on their own. So U.R.O.P. was intended to develop students' creativity."

After approximately 200 "site visits" Mr. Smith reflects on how U.R.O.P., seen through the eyes of the students, measures up to its original intent.

"When you ask students what U.R.O.P. has done for them, they all

Teaching Students to be Independent of Formal Education

A student tentatively walks in the door.

"When do you want to start?"

He or she is curious, a little unsure, a little young. But there, too, is optimism, a fresh perspective, a great deal to contribute to the faculty, as well as to receive.

U.R.O.P. has created a situation in which student and faculty members work as colleagues in the laboratory — "and it's not always clear who's teaching whom. There is an atmosphere of emotional and intellectual expectation on both sides," says Margaret L. A. MacVicar, '65, associate professor of physical sciences, founder and only director of the program since its beginning ten years ago.

For the students, it offers a unique and invaluable opportunity. They learn to present their plans, sell their ideas, do their work, and then report back. They must think through how practical their plans are: "I want them to be able to lay out projects to see if they are realistic time-wise, to see how long delays will be," explains Professor MacVicar.

The results are exciting. "I watch their carriage change," she says. "The biggest returns students get (even if they are originally shy) is the initiative to seek out and do a project. Their education starts in learning how to knock on the door. And it's not cut and dried how you do it."

Atmosphere of Trust

The kind of student that comes to M.I.T. has great potential. All come with excellent high school recommendations. "But that shouldn't be enough to get out of M.I.T. four years later — they should have fulfilled some of that promise and potential," says Professor MacVicar. Through U.R.O.P., they have the chance. "That's what M.I.T. has to offer them that's special," she adds. (The opportunity has not gone unnoticed — many would-be students ask the Admissions Office about U.R.O.P. even before they apply.) "Several colleges offer good courses, but here they get the opportunity to try their ideas, to be treated in a dignified way as a learner, to have personal contact with faculty in an atmosphere of trust and largesse.

"And their professors are asked to judge them by their enthusiasm, chutzpah, and accomplishment. It gives them room to stretch. In my own research group, for example, we expect great things. Sometimes we get great things. If we don't expect it, it won't happen."

U.R.O.P. is not a program for students alone. Said one faculty member, "I find these students make an intellectual as well as a practical contribution to my group and to me. The interaction with these undergraduates is one of my major reasons for remaining at M.I.T. and in the academic world." Added another, "Undergraduates are very innocent when it comes to research. They are not opinionated and don't scoff. They are willing to take risks

Continued on page A5

Bob Schaffer, '80, directed and acted in Black Comedy put on by the M.I.T. dramashop last spring. Photo: Tom Bloom, courtesy the M.I.T. Dramashop

say the same thing: 'It's given me a break from the classroom; it's made the work more interesting.' But when you ask them what has U.R.O.P. done *to* you? How has it changed your philosophy? You get the really exciting answers. The students say things like, 'Well, it's made me realize that I'm right — that this is what I should be.' For a pre-medical student the big question that comes up is, 'Do I want to be a clinician or a researcher?' For some students the question is: 'Do I want to be a doctor at all?' U.R.O.P. is a golden opportunity to find those things out."

Mr. Smith always asks students, "Has U.R.O.P. helped your marks, hurt your marks, or had no effect on your marks?" He gets all three answers, he says. "Some say, 'It has definitely helped my marks because what I've been learning in the classroom now has an application in the lab.' Others say, 'It's hurt my marks some because I've been too absorbed in it. The project has fascinated me, and I think my work has suffered a little bit.' Others say they don't think it's made much difference."

Mr. Smith also asks, "How do you like M.I.T.?" Many students say, "Well, if you ask me if I like it, I don't know. But if you ask me whether I think it's the greatest education I can get," they say, "there's no question about it."

No Complaints, No Changes

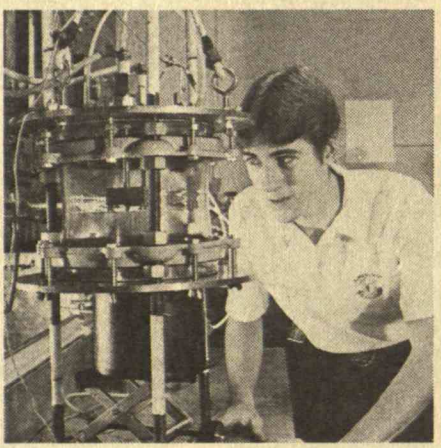
U.R.O.P. has been one success story after another since it began ten years ago. The basic philosophy of U.R.O.P. has not changed over those ten years, but there have been great changes within its operation. The increase in off-campus projects, the ever increasing enthusiasm of both students and faculty, the broadening of the educational spectrum covered have been part of this evolutionary advancement of U.R.O.P. as an important item of the undergraduate "menu." Even students who disliked their U.R.O.P. project have few complaints about the system or the concept of undergraduates doing research. Some find out that research isn't for them and they drop out of it. But as Greg Smith says, ". . . That's productive, that's constructive, that's valid. To my mind, the greatest value of U.R.O.P. is that it opens horizons to the students so that they can really think through what they want to do.

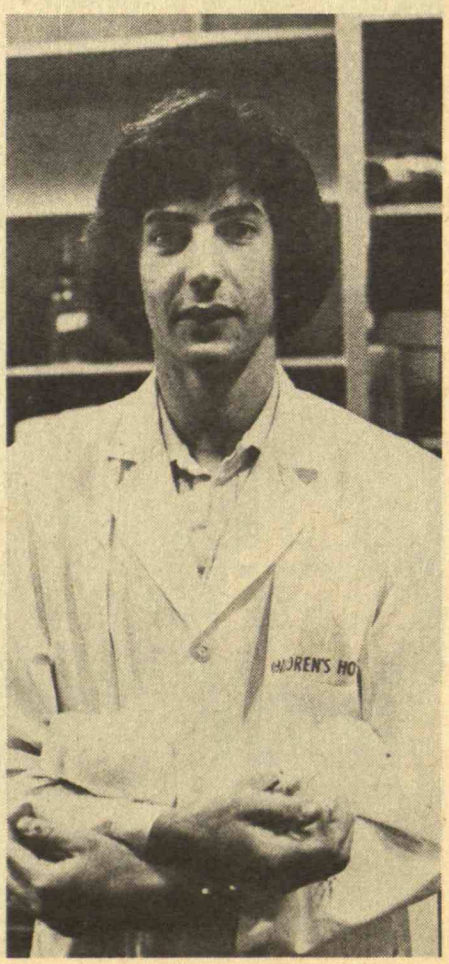
"You can't say that every student should have a U.R.O.P. project," Greg Smith admits. But it's sad, he says, that every student doesn't want to try it.

After I talked with Greg Smith, Norma McGavern, Associate Director of U.R.O.P. gave me a list of some U.R.O.P. projects that had been funded last summer, and I did four of my own "site visits." I wanted to see what the students would tell *me* about the effects of U.R.O.P. on them and what they had done with the opportunity that U.R.O.P. provided.

I. "Kindling" as a Model for Epilepsy

First I visited Andrew Krystal, '82, and Lisa Mistler, '82, who are working together on a project conducted by Dr. Michael Duchowny at the Chidren's Hospital Medical Center, investigating the "kindling" phenomenon in rats. "Kindling" is the periodic application of an electrical stimulus to part of the brain, inducing





Clockwise from top left: Professor Margaret MacVicar, director of U.R.O.P., watches Ann Serby, '82, cutting a brain into very thin sections for study. James Curme, '82, studies a batch reactor he helped construct for pyrolysis experiments connected with his U.R.O.P. project. Andrew Krystal, '82, holds his experimental subjects (rats). Miguel Mitchell, '82, is using a capillary viscometer to measure the viscosity of a protein solution. Photos: Calvin Campbell, Beth Marcus, '79.

the progressive development of electrical and behavioral seizures. Such a seizure is a set of neurons firing synchronously in some area of the brain. Andrew and Lisa explain:

We believe that the electrical stimulus first causes the brain to seize in a very specific area; more stimuli cause the seizures to spread to other parts of the brain, leading eventually to a more generalized seizure which has accompanying behavioral effects.

We stimulate the rats with electrodes implanted in various areas of the brain and watch the seizures on an electroencephalograph and in the rat's behavior. The first stimuli cause freezing, arched backs, and reflex action. The response progresses to facial clonus — a shaking up and down of the head. After still more stimuli the rat responds by rearing up and moving its front paws. Finally, in a full seizure, it falls over and its back legs go.

"There's evidence of a change in the brain as a result of these repeated stimuli," Andrew explains. "Each stimulus apparently induces a higher level of neural excitability, so that the next stimulus, although equal in intensity to its predecessor, elicits a more intense neural response. An important feature of this 'kindling' phenomenon is that the stimulus-induced increases in neural excitability are quite long-lasting, perhaps permanent. Moreover, continued stimulation can lead to a true epileptic state with spontaneously recurring seizures. These features have attracted attention to 'kindling' as a way to study cellular mechanisms of epilepsy in the brain, and it may also turn out to be a model for learning and memory because it reflects a long-lasting change in the brain," says Andrew.

In addition to taking experimental data on the animals, including recording and analyzing electroencephalograms, the two students have learned how to implant electrodes (which includes learning the anatomy of that region of the brain being used), and have been responsible for postoperative care of the animals. They have also begun a study of their own on how "kindling" affects memory, through which they hope to elucidate some of the mechanisms in memory and learning.

Of U.R.O.P., Andrew says, "I was really impressed; it's a program that's well organized and effective."

"We're constantly learning, and that really pleases me. The people we work with are always willing to answer questions, explain or show us how to do things," says Lisa.

II. Theater Apprentice in Williamstown

On the other end of the spectrum is Bob Schaffer, '80, majoring in biology and writing & literature. Bob spent two years working with Professor Gene M. Brown in the Department of Biology on a U.R.O.P. project. But he has also spent much of his time working with Professors Robert Scanlan and Joseph Everingham in M.I.T.'s Dramashop. And when he was offered a summer apprenticeship with the Williamstown (Mass.) Theatre Festival, he jumped at the chance — "an unparalleled educational opportunity," he thought, since he's considering the theatre as a possible career. (The Williamstown Theatre Festival is considered by many to be the most prestigious summer theatre in the

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and try anything in a lab."

Approach to Unusualness: Maybe It's Possible

U.R.O.P. was ten years old in September. It began in the middle of troubled times. People were questioning the kind of relationships that existed in the M.I.T. community. "What was needed was a closer tie between faculty and students in the research arena," says Professor MacVicar. U.R.O.P. gave the student a legitimate area of close interaction with the faculty.

Beginning as a 9–month program with 120 students, U.R.O.P. has grown to a year-round program of about 2,600 students (65 per cent of undergraduate enrollment). They participate in thousands of varied research activities at M.I.T. and in organizations off-campus (industries, hospitals, government agencies, museums). For academic credit, a salary, or for the love of it, students usually spend from 8 to 15 hours each week on their project.

The U.R.O.P. office serves as a source of information and coordination for research efforts, and manages an annual budget of $1.3 million. This funding comes from many sources: M.I.T. general operating funds, grants from faculty members' research contracts, and sponsored research awards to undergraduates from outside organizations.

Needs are varied — a student may need two porpoises, for instance, or a place to stay in Washington, or a way to arrange a different academic load. "One thing that is important to retain is individual responsiveness," says Dr. MacVicar. We are constantly listening to ideas — to unusualness, she says. U.R.O.P.'s approach: maybe it's possible. It just means putting together some way-out arrangements."

Students write evaluation reports for the U.R.O.P. office once each semester, and Professor MacVicar and her staff read them all, trying to recognize difficulties and then help. "We try to follow up on anyone who has a problem, even if it's not a 'said' problem. If Mary Jones says she was left on her own, for instance, we check to see if she got *no* attention or whether she refused it." All this takes tender loving care and a lot of personal contact from the U.R.O.P. staff. "The main thing is that whatever else happens, we're willing to negotiate," emphasizes Professor MacVicar.

"We try to understand the temper and politics of each department and then set a course of guidelines, values and rules that fit," she explains. "We try not to be narrow but to keep options open. Rarely does a situation come along that can't be worked out."

The flexibility of the Registrar's Office is crucial. "We can tell a student to look around, see if he or she likes it, and leave him or her room to decide," says Professor MacVicar. A student can add a U.R.O.P. project at any time and end the research any time. At the end of a semester, a J grade can be awarded, which means that the research is continuing; it's not an Incomplete.

Continued on page A6

James Hancock, '80, with a wind tunnel test model of the submarine rubber fairbody.

nation. The intent of the Workshop in which Bob is an apprentice is "to give young people the chance to decide if careers in the theatre are for them.") Being familiar with U.R.O.P., Bob wondered if the program could be a way to fund the summer at Williamstown. Professor MacVicar, who emphasizes U.R.O.P.'s flexibility to respond to requests such as this, approved. In addition to the apprenticeship Bob collected notes he hopes will be useful in the M.I.T. drama program and in the design of a new theatre which is now being planned at the Institute.

Bob reports that his apprenticeship involves in-depth exposure to all aspects of theatre production, with particular emphasis on acting and directing. So far he's acted in two of the first four main stage productions, *Camino Real* by Tennessee Williams and *The Resistable Rise of Arturo Ui* by Bertolt Brecht. He has worked with the set designed for *Matchmaker* by Thornton Wilder and with company actors on their lines for *Hay Fever* by Noel Coward. In addition, he's attended several seminars and regular classes. Bob's apprenticeship wasn't finished when I talked to him, but he had seen enough to say, "I've pretty much decided to make a life in the theatre as a director, and I think I can make it." He was asked to take over the staff position of Properties Master for the last production and intends to return to Williamstown next summer.

III. A Robot Submarine for Ocean Floor Mapping

James Hancock, '80, has been working on the M.I.T. robot submarine project with Professor Douglas Carmichael since February, 1979, a year after he transferred to M.I.T.'s Ocean Engineering Department from the University of California in Santa Barbara. His part of the project is the design and fabrication of the nose and tail cones and four control fins for Robot II. He has also worked on other aspects of the submarine such as the ballasting system.

M.I.T.'s first robot submarine, nicknamed *Albertross*, was designed and built by students during the summers of 1973 and 1974. The body was cylindrical and made out of sheet aluminum with fiber glass nose and tail cones. The submarine was

"He is told, the moment he arrives, that his secret dream of greatness is a pipe-dream . . ."

Many Different Facets to Any Field

Participants are as varied as the functions of the U.R.O.P. office. Some may be in academic difficulty, when all is going wrong. U.R.O.P. is a chance to change direction, to perhaps arrange a light academic load, or to gain moral support. Others may be precocious, ambitious, bored — almost in trouble because of arrogance — and also in need of something.

What students discover is that there are many different facets to every field. A student who is interested in lasers, for instance, will see that they can be used in completely different ways: in medicine, for attaching retinas; in civil engineering, for tunneling through mountains; in physics, to assure the accuracy of a result. The student is then afforded a myriad of choices: he or she can go out and meet a variety of people; he or she can look at a broad cut through any particular field of knowledge.

So what is really needed is time, not money — time for faculty members (and professionals in the field) to share with the student their expertise. People contact, and the attitude of those involved, is important. "When we go into a company, for example, we're looking for a careful balancing of challenge and rewards," explains Professor MacVicar. "We want to say, 'This is an M.I.T. student. He or she is capable. We don't want anyone crushed, but the project should also go as far as the student wants to take it.' "

A Chance to Explore Novelty

Edwin H. Land, president of Polaroid Corp., set for the idea behind U.R.O.P. in his famous lecture, "Generation of Greatness," in 1957. He said then that the college system hits new students with lectures, quizzes, and an attitude which systematically drains them of their fragile aspirations and dreams of greatness. He said that universities treat an adult as a child: ". . . He is

entirely self-controlled, having an autopilot and an on-board minicomputer, and was intended for ocean floor mapping. But it was plagued with mechanical and electronic problems. At that time the Navy decided to fund a research project to develop a miniature submersible capable of mapping the continental shelf with a high degree of resolution. Thus began Robot II.

Robot II has four sonar devices — a side-scan sonar to collect data giving a profile of the sea floor, a collision-avoidance sonar which scans forward from the nose of the sub, a communication sonar for control, and a bottom-following sonar to keep the submarine at a constant distance above the ocean floor. Like *Albertross,* the new sub is eight feet long and has nose and tail cones made of fiberglas; but its body is shaped as a fourth-order polynomial of revolution, and it's covered with a stretched rubber skin with a longitudinal zipper. Rubber was chosen for simplicity, and the zipper allows easy access to the internal components — like its inspiration from the wet suits that divers use in cold water, says Jim. The coefficient of drag of Robot II is one-third that of the Albertross; this means it has better capabilities — it can go further, faster and for longer periods of time.

It is also hoped that as the rubber skin is inflated by water which is coming through a hole at the nose cone, it will conform to the pressure contours of the surrounding water. This will give Robot II better hydrodynamics than its predecessor.

Before Jim came to M.I.T., he feared U.R.O.P. would be nothing more than a "time-sink." Now he says "it's the largest single factor that distinguished M.I.T. from other universities. . . . The opportunity for undergradautes to have hands-on experience with professors is invaluable." He's learned fabrication skills, but that's not the important thing. "U.R.O.P. has taught me a great deal about the engineering approach to problem-solving, and how to work with a group of engineers. I now understand the process of formulating ideas and its shortcomings." For Jim the hobbyist, design was making things, doing what came to mind first. His U.R.O.P. work taught him that the first idea is not always the best solution, says Jim. U.R.O.P. did not really affect his career choice, Jim says — "I knew I wanted to be an engineer since I was 12." But it did expose him to a wider range of things than he could find in the classroom.

IV. Venous Filters and Research Regulation

Martin Prince, '80, began working on nitinol filter research with Dr. Morris Simon at Beth Israel Hospital as a U.R.O.P. project one-and-one-half years ago. Their goal is to simplify the treatment of pulmonary embolism.

Pulmonary embolism is caused when a blood clot, developed in the lower body, breaks loose and migrates to the lungs where it can clog a major vessel, thus preventing the blood from being oxygenated. In some patients it is necessary to insert a filter in the vena cava, a major vein, to capture potentially fatal blood clots before they get to the lungs. In the vena cava, the body can more effectively deal with the clots. Implanting currently-available filters involves complex surgical procedures. The researchers at Beth Israel are making the filters of nitinol, a unique ma-

told, the moment he arrives, that his secret dream of greatness is a pipe-dream; that it will be a long time before he makes a significant, personal contribution — if ever.

"He is told this not with words. He is told this in a much more convincing way. He is shown, in everything that happens to him, that nobody could dream that he could make a significant, personal contribution.

"He is given courses, he is instantly given tests, and he is given examinations. Now I ask you, if this is preparation for life, tell me where, where in the world, where in the relationship with our colleagues, where in the industrial domain, where ever again, anywhere in life, is a person given this curious sequence of prepared talks and prepared questions, questions to which the answers are known? . . .

"If we wonder why so few pupils survive the university system in the country today — survive to come out asking the right questions, feeling free to question the authority of science although they have mastered the techniques — I suspect it starts here."

Chancellor Paul E. Gray, '54, U.R.O.P.'s mentor since its birth, is similarly concerned: "The most important outcome of education," he says, "is to bring students to be independent of formal education. How do you deal with novelty, how do you ask suitable questions, rather than answer questions someone else has asked? If we don't succeed in that way, we have failed our students. If they can't educate themselves outside of the educational environment, then we have not met our educational responsibilities."

It's not surprising then that U.R.O.P. is designed to bring the student face to face with novelty and with the unknown. "Each incoming freshman," said Dr. Land, "must be started at once on his own research project if we are to preserve his secret dream of greatness and make it come true." U.R.O.P. colors the M.I.T. education, nudging it towards Edwin Land's vision. — *M.L.*

"The most important outcome of education is to bring students to be independent of formal education."

terial with thermal memory, thus simplifying the procedures associated with implantation. Nitinol becomes rigid at body temperature but is pliable at low temperature. Thus you can insert the nitinol into a catheter at low temperature, when it is flexible; and when it emerges from the catheter into the vena cava, it becomes a rigid filter.

For nine months now the researchers have been testing the filters in animals and making design modifications. They've also been trying to make sure the filter is not toxic and does not cause clots on its own. Martin has been preparing the animal experiments, manufacturing the filters and delivery apparatus, and performing autopsies on the animals.

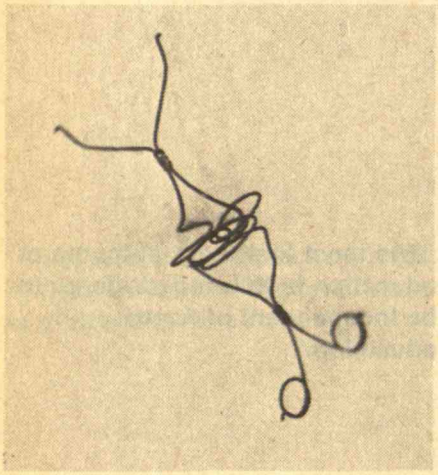
But last summer Martin received an Eloranta Summer Fellowship through U.R.O.P. to study new government regulations on medical devices — especially those that will affect the nitinol filter research. Martin also intends to evaluate the effect of these regulations on medical research at M.I.T. in general — especially their effect on experimental work with humans. Martin wants to continue this year on the development of a better simulation of the vena cava — a new simulation apparatus which he says would be used to evaluate all currently available vena cava filters, including the nitinol filter. He hopes this will be the basis of his undergraduate thesis.

Martin says U.R.O.P. was one of the reasons he decided to come to M.I.T., but he never realized what it meant until he became involved in a U.R.O.P. project. It was a whole new perspective, he told me — "a chance to apply what you've learned in courses in a different, more practical way, a chance to relate to people in a way that you will have to if you pursue a career in research.

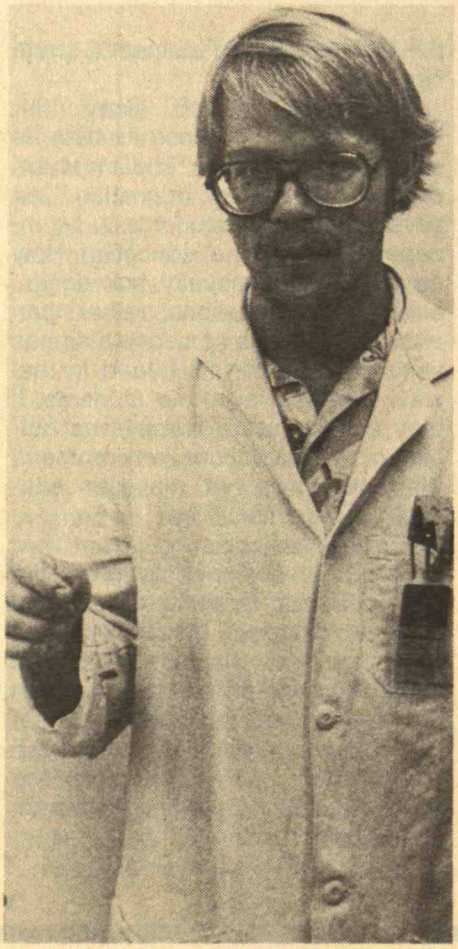
"It's exposed me to both the desirable and undesirable aspects of a career in research medicine," Martin said, and he likes what he's found: "I've definitely decided to go on into medicine." And in doing so he'll have "a head start," he says, because U.R.O.P. has given him a chance to "develop the knack for research. What I do in a week now would have taken me at least a month, maybe all summer, back when I first started."

"Getting Their Hands Dirty"

After these "site visits" — and thinking about my own experiences with U.R.O.P. — it seemed that maybe U.R.O.P. should be retitled the M.I.T. Educational Explorers Club." I remember my experiences on an Expedition Training Institute archaeological expedition to St. Kitts, West Indies. The idea was to get hands-on experience in archaeology; but it wasn't only hands-on experience — at the end of a day we were often covered from head to toe with remnants of a previous civilization. To quote a T-shirt that many of us wore that summer, we were "digging the garbage of dead Indians." In much the same way, U.R.O.P. students are "getting their hands dirty," often literally too — and getting exposed to the glamorous and the not-so-glamorous sides of research. They are coming away from the experience with a better understanding of themselves and of "the real world" into which they will soon be thrust. They are better prepared to make decisions about their lives because they have smelled, touched, tasted, and been immersed in their field.



Martin Prince, '80, holds the nitinol filter (above).



Beth Marcus, '79, is now a student at the University of London, Imperial College, having received a prestigious Marshall Scholarship from the British government last spring. She completed her bachelor's degree in mechanical engineering in January, 1979, and her master's in the same field at the end of the summer. She's now pursuing a Ph.D. in biomechanics.

"I Felt Like Alice in an M.I.T. Wonderland — Bewildered, Baffled, and Fascinated"

What's it really like to be a student at M.I.T.?

Everyone at the Institute has his or her own ideas, and by the end of the summer the chorus of answers directed at the fall's newcomers — this year, the Class of 1983 — grows cacophonous.

Here's a distillation of some of these images:

☐ In the outside columns of these pages, a description of M.I.T. for members of the Class of 1983 by Thomas A. Curtis, '80, from the midsummer issue of *The Tech.*

☐ On these and the next pages, pictorial selections from *Technique 1979.*

☐ Under *Technique*'s pictures, some relevant and irrelevant quotations from students as assembled by Bonny S. Kellermann, '72, assistant dean for student affairs, for the 1979–80 *Freshman Handbook.*

Our own cacophony — just a sampling of the louder one that surrounds us as the community eagerly anticipates the arrival of its new generation. — *J.M.*

M.I.T.: Somewhere Between "Gnurd City" and One Happy Family

These comments about M.I.T. — advice and perspective for the Class of 1983 by Thomas A. Curtis, '80 — are excerpted with permission from The Tech *for July 24, 1979.*

Someone has probably told you that M.I.T. is "gnurd city." He probably painted a picture of a long procession of numbers eagerly pursued by students packing calculators and spouting Fortran.

You may be relieved to know that this is not an accurate picture of M.I.T. True, you will find that work here will require a lot more attention than work in high school did. It's also true that all the buildings and departments here are known by numbers. However, M.I.T. is not a 24-hour-a-day grind, and students here are not inclined to spend all their time studying. In fact, there is con-

BURTON HOUSE © TECHNIQUE

siderable peer pressure not to study.

In some ways, the academic life at M.I.T. is better than in high school. Classroom attendance is not required, and many students skip half their classes. You can usually pass a test with a grade below 50. In fact, I once passed a course with an 18.

Thus, as you can see, M.I.T. is not such a horrible place. But it's not paradise either.

A Real Place with Real People

By now you've probably looked through the *Freshman Handbook* and noticed a lot of pictures of smiling students. From appearances, you may think everyone here likes everyone else and the M.I.T. community is just one big happy family.

This view is no more accurate than the first one. All the pictures of smiling students are there to persuade you to come to M.I.T. In reality, students here can get into heated arguments. In addition there are some very obnoxious people at M.I.T. Although living group cohesion is strong, M.I.T. could hardly be called one big happy family as school spirit is almost nonexistent.

Don't get me wrong; people at M.I.T. can be very friendly and helpful. However, M.I.T. is not all smiles and togetherness; it *is* a real place with real people with real personalities.

Thus, in many ways, M.I.T. is a lot like any other place you've been. However, there may be at least one big change when you get here.

Living Together, Getting Drunk, Getting High . . .

For the first time in your life, you will be able to make all your own decisions without your parents looking over your shoulders. There will be a lot of decisions to make.

Being away from home will open up many options for you. Living together, getting drunk, and getting high are all accepted on campus. However, let me again remind you that M.I.T. is not a paradise. Student freedom is not unlimited.

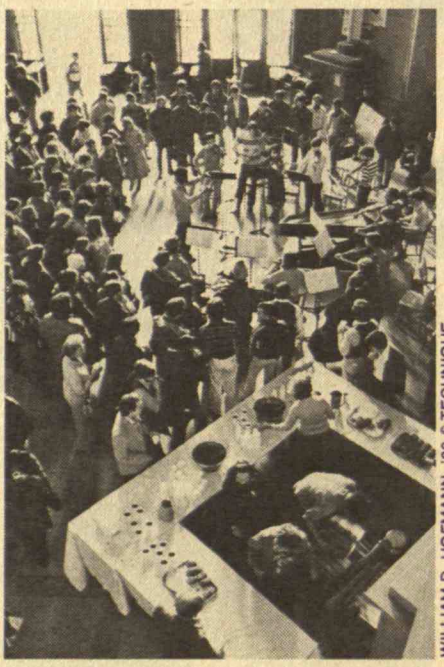
Finally, remember that no matter how much you read about M.I.T., you will never really know what the school is like until you get here. So keep an open mind and get ready for a unique experience.

CARL L. ENLOE, '81 © TECHNIQUE

"M.I.T. is a jungle; but it's one with some nice open paths and clear spots. The trick is finding them."

JOHN LEPINGWELL, '80 © TECHNIQUE

"M.I.T. might have more gnurds and turkeys than it deserves, but it also has many more dynamic, innovative, and creative people than it deserves. Nowhere else will you find a student body where so many individuals offer something unique in their own special way."



WILLIAM D. HOFMANN, '80 © TECHNIQUE

"Meeting and knowing new friends has been the best part of my year at M.I.T."

"I wanted a challenging university and I got one. I'm happy."

AEPI © TECHNIQUE

"It's easy to believe that M.I.T. is inhuman, 'til you realize it's made up of some very human people."

GORDON R. HAFF, '79 © TECHNIQUE

"If you come here hoping to gain an intrinsic understanding of the laws of the universe, you may be in the right place. For example, take the dimension of time. Although before you may have only a vague idea of what time really is, your perception of it will become strikingly clear when the night before a final you don't have any."

JOHN LEPINGWELL, '80 © TECHNIQUE

"You will not have enough time to attend all your classes and do all your assignments unless you do nothing else. You will have to learn the art of judicious punting. Don't worry: everyone has to punt once in a while."

"Wilson's Law: The intensity of dark circles under a student's eyes is inversely proportional to the time remaining in a term."

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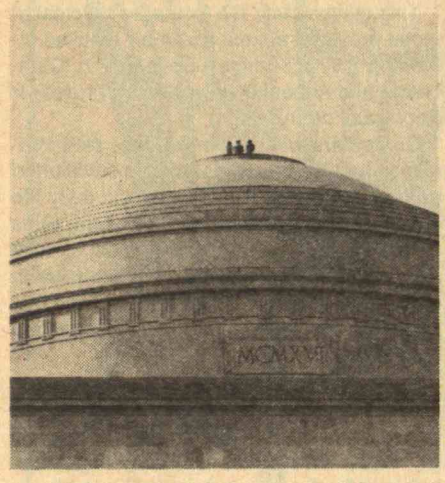


JAMES J. SNYDER, '80 © TECHNIQUE

"Sports here are hassle-free. If you're not good, you're not alone."

"You need 360 units to get your degree, and there are 360 degrees in a circle. So unit is to degree as degree is to circle, and when you graduate, you're back where you started."

JOHN LEPINGWELL, '80 © TECHNIQUE

JEFFREY D. THIEMANN, '80 © TECHNIQUE

"Don't be a gnurd. . . . M.I.T. offers as much outside the classroom as it does inside."

"I was amazed at how easy my first quiz was. I was also amazed at how poorly I did."

JOHN LEPINGWELL, '80 © TECHNIQUE

WILLIAM D. HOFMANN, '80 © TECHNIQUE

"Develop an affinity for forms, cards, and documents. Beneath the stone exterior there beats a heart of pure paper."

Alumni Summer College: Emerging Technologies

Our society literally thrives on information — whether it's a lawyer's advice, our monthly bank statements, or the rippling tones of a symphony orchestra. Nearly half the U.S. population is employed in the production of symbols.

But much of this prodigious outpouring of information goes undigested. According to a census of words flowing in Japanese society (Dr. Pool believes this is relevant to the U.S. as well), the production of words is leaping ahead at a much faster rate than the consumption. And this fact, together with increasing mechanization, suggests to Ithiel de Sola Pool, Professor of Political Science at M.I.T., that the future holds a decline in the "expediential part of this intellectual activity."

In the early days of television, Dr. Pool explained, people would just sit down for the evening and "watch tv"; now we're far more selective: we tune in to particular programs. Indeed, whole new industries are developing to respond to people's increasing television selectivity.

Some new directions for specialized information which Dr. Pool described:

— PRESTEL: This British system provides telephone access to 150,000 pages of information from classifieds and theatre listings to encyclopedia entries. It's hooked up to one's television and users pay for initial installment and then about a half cent access charge per page. Though GTE has bought the rights for this system, Americans should not expect to use it until our heavily trafficked phone lines are relieved by optical fibers.

— CEEFAX: Another British system which sends news of weather, daily headlines, the stock market over the air waves — which limit information to about 200 pages. A device attached to the tv holds the desired frame.

— QUBE: An experiment in two-way cable communication in Columbus, Ohio, allows the viewer to select movies, receive market information, place orders, and participate in discussion programs.

— Lockeed and New York Times Information Banks: Users can retrieve all kinds of information at rates of $40 an hour.

This glimpse into the future was typical of those provided alumni and their families attending 1979 Summer Colleges in Cambridge and Aspen, Colo., of which Professor Pool was "dean."

Computers will proliferate, too, said Professor Joel Moses, Ph.D. '67. He envisioned paperless offices as business and daily life changes with new uses of computers. Elias P. Gyftopoulos, '58, and Thomas L. Neff discussed energy — how you produce it, how much there is, problems of energy sources; and Lester C. Thurow scrutinized the economy.

Apace with all these developments, regulatory processes will change, too. "Regulation is the outcome of scarcity," explained Dr. Pool. Printing in its early days was licensed by the government in England — a fact which Milton attacked in Areo Pagitica — yet 50 years later the law was repealed: the technology simply became more accessible. Now that advances in technology have given us the use of higher frequencies and more selective equipment, broadcasting has reached a similar turning point, said Dr. Pool.

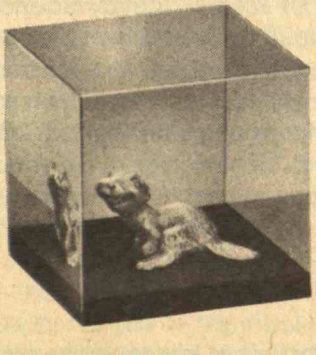
Professor Pool advocates reform which would treat the use of the radio spectrum much like the use of land. He proposes a random selection process for licensing (giving an advantage to minority applicants) and a resource fee based on the scarcity value of the spectrum used — this would pay for regulatory costs.

Such emphasis on using the competitive market as regulator would allow cable television to compete with telephone companies for voice transmission and to offer services such as fire and burglar alarms and data transmission.

But the flood of new information services will continue to leave knotty legal and political problems in its wake. Copyright laws are nearly impossible to enforce; electronic junk mail invades privacy. Easy access to foreign data bases threatens national economies and security.

M.I.T. INSIGNIA

A GOOD WAY TO REMEMBER



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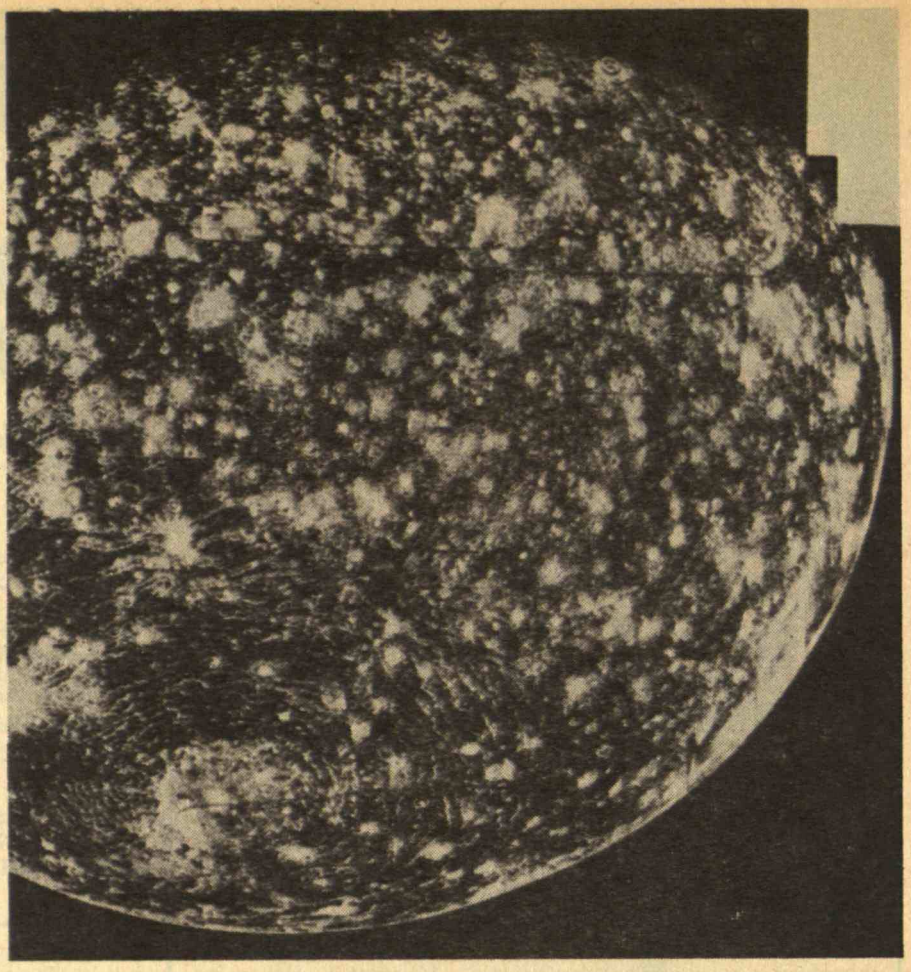
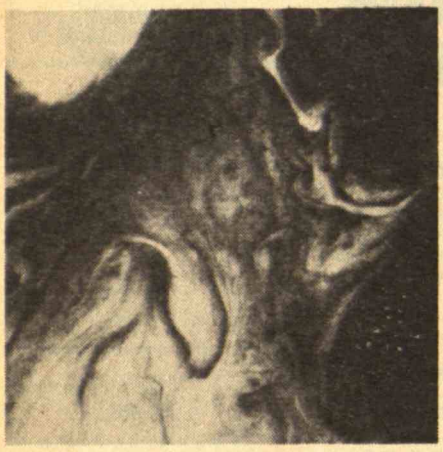


Right: Callisto, showing shock lines emanating from a large impact near the equator. The impressions are much more extensive than would occur on our moon because the surface is mainly ice. Below, top: close-up of Jupiter's flowing surface; bottom, one moon (with possible eruption) superimposed on another. Photos, pages A14-A15: John Lewis



Searching for Truth among the Stars

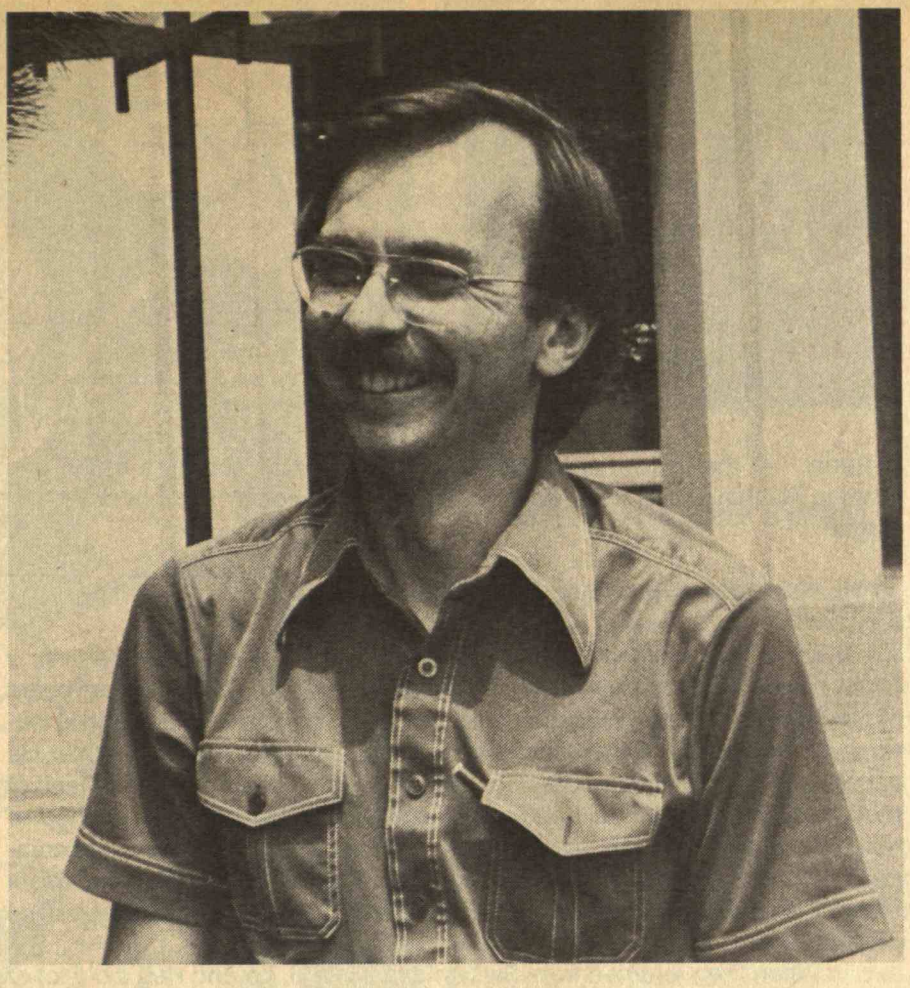
Professor John Lewis picked up a glossy color photograph just back from the Voyager mission to Jupiter, his eyes wide with excitement. "When I was a child," he said, "I had a *Golden Book of the Stars.*" He described himself, at the age of eight, staring at pictures of Jupiter's barely visible moons, thinking, "Oh, God, what is this? Look at these fantastic things — what are they like?"

Thirty years later, studying the origin and evolution of the solar system as an associate professor of Earth and Planetary Sciences at M.I.T., Lewis finds the dreams of his childhood have come to life. "All of a sudden, over a period of a few days, we go from pictures showing these things as indistinct, tiny little blurs to pictures that reveal them as planets, with all their own idiosyncrasies and complexities. Io, Europa, Ganymede, Callisto, and Amalthea — those five objects revealed like that — it's like discovering a new solar system. And for someone whose life work is planets, it's very exciting."

In a small office near the top of M.I.T.'s 16–story Planetary Sciences building, Lewis surrounds himself with elements of a life as diverse as it is wryly human. Doors are decked with cartoons, newsclippings and children's drawings. A table opposite the desk is cluttered with a mixed bag of technical papers, honey bears, baby's teething rings, and a wooden bin labelled, "Operation G.L.O. Equipment (Get Lewis Organized)." The details of his education bear out the sense that he has been integrating a broad range of interests for a long time.

Mixing Up the Sciences

After undergraduate work at Princeton and a Master's in inorganic chemistry at Dartmouth, Lewis says he gave in to "a lifelong desire to mix up all the



Left: Professor John Lewis; below, top: a composite of Jupiter's surface showing turbulence produced by the flow of its atmosphere; bottom, a volcanic eruption on Io. Voyager saw ten major eruptions and 200-300 minor ones on Io, spewing out SO_2 and liquid sulfer, one as high as 280 km.

sciences." Studying at the University of California at La Jolla with Nobel Laureate Harold Urey, one of the world's foremost experts on planets, Lewis was introduced to new data on the chemical composition of Venus. This led him to begin speculating on the processes by which planets are formed.

Later, when he applied the same reasoning to Jupiter, he concluded that its moons must have the structure and activity of evolving planets. "The satellites showed promise, in advance, of being very complex and active worlds with lots of geology going on. . . . This way of looking at the satellites of the outer planets was one of the keys to getting the Voyager mission in the first place, getting it approved by NASA." According to Lewis, preliminary data and photographs from Voyager have already revealed far greater richness and diversity among the satellites than scientists had imagined. "Many of us are going to be spending a lot of time studying those satellites in the next few years," Lewis said, adding that each one was as interesting as any one of the planets.

Earlier studies have already confirmed the presence of a number of compounds Lewis predicted would be found on the surface of Jupiter, one of which provided a triumph for Lewis in a continuing series of disputes with science-popularizer Carl Sagan. Sagan had proposed organic chemicals — the building blocks of life — to be responsible for Jupiter's mysterious crimson glow. Lewis and a former student, Ronald Prinn, wrote a paper three-and-a-half years ago that explained the coloring inorganically.

The paper said that phosphene gas, seen on Jupiter, would be torn apart by sunlight to form phosphorus gas, which would condense to form phosphorus particles that produce the red color. Sagan argued against this for a year or so, said Lewis, and then, about a month ago, observations by the International Ultraviolet Explorer satellite confirmed the presence of phosphorus gas — the missing link in Lewis' explanation — on Jupiter. "The cream of the jest," Lewis said, "is that the request to use the satellite was a joint effort of several people who did it in hopes of finding complex organic

The Lewises now live on a ten-acre farm in South Natick with their four children, 30 goats, several dozen ducks and geese, and an acre of vegetables.

material." At the bottom of the list of sponsors, Lewis added, a stifled grin twisting his thin moustache, was the name of astronomer and physicist Carl Sagan.

At Home: Stable Roots and Self-Sufficiency

If Lewis' home life creeps into his office, it is no surprise, since he lives a lifestyle as full as it is atypical of an M.I.T. professor. An outspoken advocate of the Transcendental Meditation program, Lewis has given many public lectures on the subject. He learned to meditate, Lewis said, some time after his wife Peg started, and he noticed changes in her attitude and her command of responsibility. That was six-and-a-half years ago. She later was trained to teach the technique. The whole family (then including three sons) accompanied her to Switzerland for six months advanced study with Maharishi Mahesh Yogi, founder of the technique, while Lewis worked on sabbatical projects.

When they returned from Switzerland in 1976, he and Peg did a lot of thinking about how they wanted to live their lives. According to Molly Rauber, Lewis's secretary, they decided they wanted to have stable roots for their children and to try to be financially self-sufficient.

The Lewises now live on a ten-acre farm in South Natick with their four children, 30 goats, several dozen ducks and geese, and an acre of vegetables. They are almost entirely self-sufficient for food, and sell produce and goat's-milk products in local markets.

Keeping the farm takes a considerable commitment of time and dedication from both of them. "This entire lifestyle would be entirely impossible without the meditation," he said. "I wouldn't have enough energy and 'stick-to-itiveness.' To manage everything — a profit-making farm, a full-time job, time in Washington — takes energy. I seem to get through them with no sign of strain."

Has Lewis's unusual lifestyle affected his work? Colleague Ronald Prinn thinks not. "I don't think it affects his interaction with people in the department. I think it adds another dimension. . . . For a scientist to be successful, he has to be happy with his life." His devotion to thought processes can be most productive in a happy environment, he continued.

Prinn has collaborated with Lewis on a number of projects through the years: "We have very different approaches — John's more conceptual, mine more analytical and deductive. He always sees the greater picture."

Lewis describes his approach as more of a "synthetic" or integrative one. "Most scientists are trained to analyze things — to take them apart," he said. "But there's nothing in their education that shows them how to put them back together." "Putting them back together" again allows him to grasp the more universal truths, or laws of nature at work in what he studies. "The most creative scientists," he said, "are those who are active in many different areas. Those who search for absolute truth in science probably bear more in common with monks than with the regular production-line everyday scientist." — *Judith Becker*

Joe LaMantia

Visitors in a Small Planet

by Steven J. Marcus

"We are all flowers of the same garden," say my friends of the Baha'i faith. All different, but so much alike. Sizes, shapes and colors may vary, but all are nourished by the same Earth, warmed and sustained by the same Sun, and live doing much the same thing. If the ancient rose bushes in my neighbor's yard could speak with the columbines nearby, they probably wouldn't dwell on their differences ("Why is your perfume so strong?" or "Where'd you get that garish color combination?"). More likely, they'd talk about their offspring, complain about the weather, and compare notes on the bees with whom they do business.

This is what I find so remarkable and exciting about meeting people from far away. They look and sound different, it's true, and their perspectives are often quite unique. But their interests and concerns are so much like our own, and conversation flows so easily, I wonder if they merely rented their costumes, put on a mock accent, and in fact live right down the street.

Mr. and Mrs. Charles Wang, '39, visitors from the People's Republic of China, recently spent a morning with the staff of *Technology Review* in our offices at M.I.T. It was, without doubt, an unusual "cross-cultural experience" — there are some 900,000,000 of their compatriots, but how many of us have ever met one? With "normalization" between our two countries now underway, it may not be long before such encounters become routine. And what a treat awaits us. If this couple is at all typical of our rediscovered allies on that great inscrutable mainland, then we'll soon be mingling freely with people just like our favorite friends and relatives. (Mr. Wang, in fact, reminded me of my late Uncle Sol — alert, intelligent, humble, with a wry sense of humor and an infinite supply of stories. Unlike Sol, he didn't smoke cigars and blow smoke rings, but I can forgive him that omission.)

Shanghai — the New York of China

The Wangs live in Shanghai — it sounds like the New York of China to me — and like New Yorkers they disdain the country life. The culture of the big city, and the day-to-day contact with many different people, are what turns them on. The Wangs had been staying in Weston, a Boston suburb that is beautiful, and quiet, in a house with every modern convenience (and a swimming pool, no less), but they gave it all up for a room in an M.I.T. dorm. "I wanted to use my legs," he explained.

Legs and bicycles are the Wangs' preferred means of urban transport. Automobiles are not common in Shanghai — they are astounded by the number of cars in Boston's streets — but what

"When I heard them play 'Stars and Stripes Forever' over Peking TV, I knew that everything would be all right."

Chinese cars lack in numbers is made up for in noise. Another difference is the urban landscape. They are awed, but not favorably impressed, by tall buildings that diminish the quality of the pre-existing environment. M.I.T. is a "temple of technology," and its older buildings are literally temple-like — with powerful columns, soaring domes, and dignified courtyards. Mr. Wang was distressed that the Emerald City he remembers is now dwarfed, and with no particular elegance, by salient towers-come-lately.

Mr. Wang used to spend a fair amount of time at M.I.T., having studied electrical engineering here. He was graduated in the class of 1939, stayed on another two years to earn his master's degree, and then returned to China. He didn't think he'd ever be able to visit America again. But international relations do change, and what was unthinkable only a couple of years ago was now a reality — he was able to attend his 40th class reunion, visit old friends, see his venerable father (who was in America all these years and lives in Tenafly, N.J.), and even accomplish a good deal of professional development. Mr. Wang is an engineer at a research institute which designs electric motors for the entire country, and he is visiting with many of his American colleagues as part of China's new interest in innovation throughout the sciences.

For Science: A Leap Backward

The Cultural Revolution, as far as science and technology were concerned, was a great leap backward. It was a time of hardship for all Chinese "intellectuals" (those having had some higher education), but especially for technologists whose jobs, almost by definition, were remote from the people. Mr. Wang, a Senior Engineer, was stripped of his title and put to work as a manual laborer for six years. He came out the better for it, he believes, and was even an outstanding worker. His

former title and responsibilities have now been restored, but he speaks sadly of friends who "didn't make it through."

The unwavering faith of the Chinese people in the benevolence of the government didn't make it through, either. "For the first seventeen years of the Communist regime, " he said, "people had great confidence in their leaders." But the government "took advantage" of its power, and lost much of its prestige. Restoring the confidence of the people, and recovering lost intellectual ground, appear to be among the highest priorities of China's present leaders.

We have an image of regimented life in China. And by American standards, it's true. Picking a career in Chinese society sounds like choosing a specialty in the U.S. Army — you indicate your preferences, but the authorities make the choice. A young acquaintance of Mr. Wang's, for example, wanted to be an aeronautical engineer — the government trained him in forestry. The bad news, obviously, is that you may not get your first choice; the good news, however, is that you're guaranteed a job. You also cannot quit your job. But no one can fire you, either. It is possible to switch careers later on, but this becomes literally a "federal case."

TV Without Commercials

What is the preferred form of entertainment? we asked. The Wangs didn't hesitate for a moment — television, they said. And being the proud owners of a color TV, they do not lack for visitors. Shangai has two channels — one local and the other originating from Peking — which carry news, sports, and movies. And the movies aren't oldies, but *first-run* (as good a reason to go socialist if ever there was one). Most of these current films are Chinese-made ("of local interest," as Mr. Wang described them), but older foreign movies are also broadcast. "Gone with the Wind" made it to Shanghai TV, as did "the one with all that do re mi" ("The Sound of Music"). But some of the other American films that got there made us wonder what the distributor had in mind: the Wangs had seen "Futureworld"; and another one whose title they forgot but which sounded an awful lot like "The Sugarland Express." Commercials on TV are unknown to the Chinese, and when Mr. Wang saw his first commercial on American television he thought that he'd dialed the wrong station.

Mr. Wang had not been to America in 40 years, and for Mrs. Wang the trip was her first venture into the English-speaking world. But they were both remarkably relaxed and communicative, as if they'd been here for years. They have a theory to explain it: that there is a natural affinity between the Chinese and American peoples. After a lapse of 30 years, they argued, things picked right up — just like a ballgame resuming after time out. By contrast, their strenuously cultivated "friendship" with the Russians dissolved like the foam.

For those Chinese who share the Wangs' theory, it was rough going for a long time. During the Cultural Revolution, to utter even a word in English was to invite suspicion. But in recent years, things have improved rapidly. For Mr. Wang, the moment of truth came last year while watching a televised concert of Seiji Ozawa conducting the Boston Symphony Orchestra. "When I heard them play 'Stars and Stripes Forever' over Peking TV, I knew that everything would be all right."

08

Franklin Towle writes: "Your class letter brought a telephone call from **Fred Peirce**. Because of a bad case of whooping cough in his junior year, he never finished at the Institute. He went into the instrument business where I knew him. He is now 94 years old and spends his time in Florida, Cape Cod, and Wellesley, Mass."

Frances Luther sends more information about her father **Howard Luther**, whose death was reported in the last issue. In addition to a long and active career in the engineering profession, he was also a member of a number of societies and clubs: Cinti Literary Club, Colonial Wars, Cincinnati Print and Drawing Circle, American Society of Civil Engineers, Boston Society of Civil Engineers, Cincinnati Country Club, Camargo Club and the University Club of Cincinnati. "My father was a very proud and loyal alumnus of M.I.T. and always enjoyed his class reunions."

Joe Wattles writes: "I received your letter of May 9. I am so glad you have accepted the position as class secretary. It could not be in more excellent hands." — **Harold S. Osborne**, Secretary, Penacook Rd., Contoocook, NH 03229

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There were no notes in the August/September issue as we had nothing to report. Which means — "keep in touch."

We would have liked to be able to attend Technology Day last June, particularly the Memorial Service and the sherry party for alumni secretaries. **Walter Muther** has written that there were only three 1913ers in attendance on Alumni Day: **Charlotte V. Sage**, **Warren E. Glancy**, and **Walter P. Muther**. Also there was Walt's daughter, Sally Lawton, who is certainly an adopted member of 1913. Walt reports that it was a "gala occassion" and everyone had a good time.

Charlotte Sage wrote that in spite of a stubbed toe and consequential fall, she is back in good condition and expects to spend some time with her family in Vermont.

We received the following note from **Thomas J. Lough**: "My wife Genevieve having died in January, I sold the old home and moved in with my daughter and her husband. June 20 being my 90th birthday, they entertained at dinner 55 of my friends in celebration thereof. I was one of the few using a cane — arthritis you know. I hope all is well with you." . . . Also received a most interesting letter from **Herbert G. Shaw**: "We would like to tell you about our new home, the Masonic Home and Hospital, of Wallingford, Conn. We moved here late in April after much thought and consideration as to how to best provide for ourselves as we grow older and infirm. We are now in better than average health, but we never know how long that will last. Here we will get any care and attention that we will require, and when we pass on that will also be taken care of. This home is rated as the best extended health service care in the country, and we feel that we are fortunate to be living here. We like it very much and we have a few friends who moved here before we did. My whole basement workshop was moved here with us, and I am now working on the assembly of a tall grandfather clock, so I'm assured that I will continue with my hobby for some time yet. We hope that this finds you well, and that you will continue your nice work for '13 in the *Technology Review* for many years. Your notes are what we read first each time the *Review* comes to us. Leila also sends her best regards. You may have heard of our move before this, but I wanted to tell you about it myself."

We received word from the Alumni Office that Dr. **Ralph B. Kennard** died on November 6, 1978.

My garden is flourishing and I wish I could share my sugar snap peas and my oak leaf lettuce with you all. — **Rosalind R. Capen**, Assistant Secretary and Treasurer, Granite Point Rd., Biddeford, ME 04005

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Thanks to his excellent health, **Ros Barratt** is still quite active in his profession of architecture. He works from his home in Southport, Conn., where he has lived for more than thirty years.

And **Levi Duff**, who also is in good health, wrote in June that he goes about three days a week to his old office in the Allegheny County Department of Works (Pittsburgh). His letter continues, "I spend a short day gratuitously helping them dig up old information regarding roads and bridges. There is practically no one left in the department that was there in my time. The other three working days in the week, I putter around the house tending garden and so forth." Lee went to Los Angeles in that month to the wedding of his only granddaughter. He gave her away at the ceremony, taking the place of her father, Lee's son Shannon, who passed away ten years ago. Lee wrote in July that he had a wonderful trip, that the wedding was beautiful, and that he had a nice visit with his grandchildren. He mentioned that he'd recently had a long phone conversation with **Jim Reber**, who was visiting relatives in Pittsburgh on his way from his winter home in Texas to his summer residence in New York State. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

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Loring Hall writes: "Your letter of April 16 is full of springtime pep and ginger — Ruth and I just returned from our annual spring "vacation" in Biloxi, Wis. We enjoy the golf there, and the slow tempo compared to the hectic gyrations of life in Detroit. People there don't make much money but they take time to be friendly, even to "damn Yankees." They seem to get genuine pleasure from old fashioned pursuits such as homekeeping, gardening, church-going, and just plain socializing. There is a minimum of crime and none of the racial friction that is so prevalent here in the north. I even got so I liked the ubiquitous hominy grits, which are served gratis with nearly every breakfast order. However, when hot weather sets in we are ready to come back to spring in Michigan. Our garden is already bright with color and lots more in prospect."

A very fine letter from Clifford E. Sifton, Jr.: "Thank you for your note addressed to my father, **Clifford E. Sifton**. My father is now doing fine, thank you, at age 85. He is very weak, however, and is in a nursing home in Neshanic, N.J. I thought you might convey his greetings and best wishes to other members of the Class of 1915."

Does anyone remember **Charlotte Rogers**, a "co-ed" at our time? "I'll write you an informal note and enclose a tiny token for A.M.I.T.A. At present I do not know anyone at M.I.T. All of my friends who are M.I.T. graduates are a joy to me and a true credit to the institution. I always wish that I could do something for A.M.I.T.A. In the days of Cleofan, it meant much to me."

John Staub, a very successful architect in Houston, wrote a note to Class Agent **Joyce Brado**: "Sorry I am not in shape to write you a newsy letter — but will tell you about my book. It will be on the bookstands in Texas on October 1. It's a discourse on electric architecture and nearly 80 of my homes and plans and 28 color plates. The University of Texas Press at Austin is making quite a play about it in its catalogues, I'm told, but I regret that it has become such an expensive book; I don't think it is worth it in spite of the enthusiasm of the president of the Houston Museum of Fine Arts, which is sponsoring the book.

Jim Tobey remains the learned scholar he always has been. "In 1912 or 1913 I had a course in Spanish at M.I.T. taught by Justus Erhardt, a German. Now at age of almost 85, I am taking a course in Spanish at Wainright House, in Rye, N.Y."

From Altadena, Calif., **Bob Welles** writes a colorful and interesting letter to accompany his very generous gift to the Alumni Fund. He certainly leads a pleasant life out there. "I hope to cheer you up a bit by sending you some dates from our California desert region. These dates are of a variety called Khadrawi. There are at least 15 or 20 other kinds. They of course all come from the desert regions (Imperial and Coachella valleys) where the summer temperature will seldom fall below 95° at night and 110° in the daytime. The heat is dry though and not as hard to bear as 85° in Hartford or Worcester, unless you have to work in the sun. California of course is a large state, third only to Texas and Alaska in size. It has desert, mountains, interior valleys such as the Sacramento and the San Joaquin, and coastal regions such as the San Francisco and Los Angeles regions, and four entirely different climates to match. We had about a week of hot weather here early this month and all my youngberries and boysenberries cooked right on the vines. Most of them are still red, but cooked, sour and rotting. But when peaches start getting ripe, which is the case now, most people find it easy to forget about berries and eat peaches. Apricots will be ripe in a few days and plums a few days later. I might as well admit, however, that handling heavy baskets of fruit has become more than my old joints are good for, and I am putting this place up for sale. If it sells I'll move in with my daughter. I'll miss this place, with all its room and fruits, but old joints do creak, and I'll be glad to save what I am now shelling out for a full-time gardener and a housekeeper. No plans for coming East. My traveling days are probably about over." The dates he sent were delicious.

Mary Rice writes, "The fine days I spent at McCormick all were so exciting. I'm looking forward to returning next year for our 65th Reunion. Will we have something special? I'd so like to help if you think we could arrange a 1915 get-together, however small. I'm in Sonoma, 45 miles north of San Francisco, looking for a house to move to in October. It's 106° here today — so I'll have to find an air-conditioned place. The houses are called mobile, but of course they aren't and the gardens with each are so lovely — the whole place looks wonderful — and living very gracious. There are two club houses and an oversized pool — far different from the treacherous ice and snow last winter at home. I shall return to Bronxville in August to sell my apartment and furniture and hopefully move back here October 1."

Carl Wood keeps remarkably healthy and cheerful for our age. He writes, "It is great that you are so dedicated to our class of 1915 and are doing fine work. We had a nice class report in the recent *Review*." — **Azel Mack**, Secretary, 100 Memorial Dr., Cambridge, MA 02139

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In recent years, we have felt that there may be several who would like to attend a gathering with their classmates but who find the dates at Chatham are inconvenient. At our 63rd reunion, we were urged to schedule a luncheon meeting in the fall at a convenient location in or around Boston. It appears now that we will have such a luncheon in late October at the M.I.T. Historical Collections. The details will be mailed to you in early October. At this luncheon, it is intended that we present the "original red jacket" which was introduced by Jimmie Evans and our Class for our 50th Reunion. Since that time, all 50-year classes have adopted the red jacket idea. We may also be able to present to the Historical Collections our replica of "The Bucentaur" which carried the important documents of M.I.T. from Boston across the Charles River to Cambridge. The Historical Collections may also be interested in having the magnificent collections of records and pictures which Harold Dodge maintained on correspondence from classmates and class activities.

We're happy to report that **Paul Duff** celebrated his 85th birthday in grand style with many of his children, grandchildren, and friends. Paul and Frances planned to visit in Arizona in August. . . . **John Fairfield** reports that Gladys is less mobile but cheerful and alert. They both miss the reunions. John supports the suggestion that we

schedule a memorial service for our departed brothers and their spouses at our next reunion.

It is our unhappy task to report the passing of classmates **Howard M. Smith** on January 8, 1979 and **Harry B. Smith** on June 21, 1979. Howard's daughter wrote that he died at the age of 89 having led a full and active life right up until that time. He was working on a design for a sloop for a grandson at the time of his death. He left two sons, a daughter, nine grandchildren and four great-grandchildren.

We leave you with the advice of **Nat Warshaw** — "keep walking." Please write often, even if only a few words. — **Ralph A. Fletcher**, Acting Secretary, P.O. Box 71, West Chelmsford, MA 01863

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On May 25, there was a gathering of 15 members and honorary members of the Class of 1917 at the Faculty Club, to celebrate the 85th birthday of **Atwood P. Dunham**, alias "Brick." The luncheon was an hilarious affair with speeches by everyone present. Brick was presented with a cake on which was a single candle, and a chorus consisting of the waitresses and Brick's granddaughter sang Happy Birthday. Those present were: **Stan Dunning**, Elizabeth and **Ed Payne**, **Jim Flaherty**, Katherine and **Ray Stevens**, **Jesse Rogers**, **Ali Ferretti**, Phyllis and Don Severance, Jay Stratton, Edna and **Brick Dunham**, Doris and **Bill Hunter**. Here's an interesting note from **Penn Brooks**. Our honorary member, Conchita Lobdell Pearson, visited Penn's Virginia farm for a few days. There were several parties in the area while Conchita was there, and as Penn says: "As you would expect, our honorary class member charmed all present." This winter Penn spent two months at Sanibel Island, Fla., where he rented an old cottage right on the beach and was visited by members of his family and friends and watched people collecting shells. Now back on the farm, Penn is an observer of nature; i.e., his cows' sad eyes, the Canadian geese on the pond, and blue birds raising a family.

Al Lunn was moved in June from his home in Cambridge to his daughter's home on Cape Cod. Since **Henry Strout** lives nearby in Hyannis, he visits Al once or twice a week and he reports a noticeable improvement in Al's health since he came to the Cape. This is certainly good news. . . . **Ossie Holt** called our attention to the fact that we had a classmate who had a rather notable career, news of which had been neglected by the class. We refer to Charles C. Gager who died four years ago. He earned a Ph.D. from Yale and an S.B. from M.I.T. in Naval Architecture. He served in the U.S. Navy in World War I. Later he served as an instructor at M.I.T. for three years and then joined the U.S. Navy Bureau of Ships as a principal engineer and a specialist in hull form design for all types of U.S. Navy ships. He was deeply involved in submarine design for which he was the Bureau of Ships specialist. He was well regarded for his talents by the M.I.T. Deparment of Ocean Engineering and their personnel miss him as a good friend and a major contributor to submarine design. He developed a procedure still called the "Gager-Gram" which remains standard in present design practice in the Bureau of Ships.

A note from **Sam Freed** indicates that he has retired from active management of the business he founded over 50 years ago, the Central Electric Supply Co., Inc., of Worcester, Mass. His sons, Jerry and Larry, operate the business now but Sam looks in on them occasionally. His oldest son, Aubyn, a math major, earned his doctorate at the University of Illinois, and now works at the Lincoln Labs. Sam's health remains good and his greatest joys are his wife, three sons, and seven grandchildren.

Ken Lane says "The only activity which is of any use to anyone is my active participation in the operations of the U.S. Coast Guard Auxiliary. I don't know how long I can keep it up." . . . Alicia and **Will Neuberg** have returned from their trip "Down Under" which was in celebration of their 50th wedding anniversary. Will says "the people of New Zealand are so friendly and honest that one hates to leave. From Queenstown we went to the top of Mt. Cook and stood on 600 ft. of snow. At another place, a dog that rounded up the sheep and kept them at bay, had an almost human look in his eyes. We saw the geyser at Rotorua and took a small plane over an island volcano which had been a sulphur mine where the workers were all killed in an eruption. In Australia, we made good friends in Melbourne and took a plane to Hobart, Tasmania, where we dined at a revolving restaurant atop the Casino. From Sydney, we went to Fiji. The tourist mob at Nanda in Fiji prevented us from getting our plane, so we stayed at a motel, and next morning took a plane for Suva (capital of Fiji). Next we flew to Apia (a cocoanut island). From there, to Pago Pago in American Samoa. From there we went to Papeete in Tahiti. Then a 10 minute plane ride to the island of Moorea, where we stayed for two days. From there, home to Los Angeles via Papeete."

I am sorry to report the deaths of three classmates. **Paul Leonard** died on August 28, 1978, at his home Halcyon Farms, Lakeville, Mass. 02346. . . . **John Parsons** died on May 18, 1979. His home was at 18 Rolling Lane, Dover, Mass. 02030. . . . **Dick Lyons** died in Houston, Texas, on June 10, 1979. He had suffered several severe strokes and for some time had been confined to a wheelchair. Dick had a most successful career and was a generous supporter of M.I.T., especially in his professional area of geology. To quote the New York *Times*, "he was retired president of the Union Oil and Gas Corp. and a pioneer in the use of scientific techniques in petroleum exploration. Dick graduated from Harvard before coming to M.I.T. He was an artillary lieutenant in World War I. He had been vice president of Skelly Oil, vice president of Tidewater Oil, and president and director of the M.I.T. Club of South Texas from 1954 to 1974. He was instrumental in the initiation of advanced field training for student geologists. With his wife, Sammie, he established a fund that has been named for them. Sammie is known to many in the class.

It is very good to hear that the grandson of **Clifford E. Lansil** has been admitted to M.I.T. You will remember Cliff was professor of electrical engineering at M.I.T. for many years. . . . In June, Doris and **Bill Hunter** spent a vacation at South Orleans on Cape Cod. While there, they visited Ruby and **Henry Strout**. Later the Hunters and the Strouts had lunch with **Ray Brooks** at Falmouth. It was a very good lunch and, of course, some very good conversation. . . . Since **Al Ferretti** retired twelve years ago as professor of mechanical engineering at Northeastern University, he has been involved in an amazing lot of activities. Over the years he has worked on the Lynn Council on Aging. Originally supported by a modest grant from the City of Lynn, and with voluntary personnel, it offered a "drop-in" center for the elderly to socialize, play games, and watch movies or slide travel talks. As the years went on, this simple activity has been augmented by many other activities supported by the City of Lynn, other neighboring communities, and state and federal grants. Some of these comprise a job placement bureau for those able and willing to work to help defray their living expenses, and hot lunches for the elderly for a small fee. This is for those living alone who did not provide themselves with a well balanced meal. This then became a "Meals on Wheels" project where hot meals were delivered to those who had impaired mobility. The Council cooperates with the Visiting Nurses Association in providing clinics at the "drop-in" centers. Doctors volunteer their services at these clinics and find many cases in serious need of attention. Tax assistance is provided by knowledgeable people on income and real estate taxes. Recently, one of the largest projects is the Homemaker and Chore services that provide the elderly who are not physically able to handle such tasks. Obviously such varied services require a sizeable staff, many of whom are paid, but many are volunteers. Looking after all these programs sure keeps Al busy. — **William B. Hunter**, Secretary, 711 Farmington Ave., Apt. B-9, West Hartford, CT 06117

18

These notes are being written in the middle of the summer — and news from you is at its lowest ebb. M.I.T. — which I visit as frequently as I can — is busy regardless of the calendar. In particular a convocation of scientists and churchmen from all over the world convened in these hallowed halls for the first two weeks of July — all of which is reported to you in other columns of this *Review*.

During the latter part of June there was a convention in Cambridge, Mass., of the International Biographical Centre of Cambridge, England. This organization includes only people who have achieved recognition in their fields, have submitted their biographies, and have been accepted; they meet annually and have discussion groups on art, literature, social sciences. One of its members is our classmate, **Bill Jones**, of Omaha, Neb. I had lunch with him and his wife Margaret, all of which was most pleasant and enjoyable. I am happy to report he is enjoying good health — in fact, he is responsible for "The Reaching For Eighty Daily Exercise Program" which is helping fellow Nebraskans to better health. Bill served in World War I, leaving the Corps of Engineers as a second lieutenant. Thereafter, he was resident engineer on many large construction projects; including the gaseous diffusion plant for the Atomic Energy Commission, Oak Ridge, Tenn.

A note from Robert Clogher, '38, to the Alumni Association tells of his interest in Arthur William Clogher, '93. Specifically, he wants to know what happened to him after he shook the dust of Cambridge from his feet four score and six years ago. Another equally curious Clogher is our own **Eaton James Clogher**. Any news, Eaton? — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, MA 02135; **Leonard Levine**, Assistant Secretary, 599 Washington St., Brookline, MA 02146

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Believing all classmates will be interested in our 60th year reunion, I will devote these notes to comments received to date. Firstly let me advise that financially we came out whole. **George Bond** writes "We all enjoyed it very much and are looking forward to our 70th and 75th reunion," beat that if you can. **Doc Flynn** and his wife planned to attend but due to surgery just prior, he writes "I'm glad the reunion went off well and regret not being a part of it." **Bill Vogt** writes, "I enjoyed the reunion very much." **Ev Doten** writes "It was a very successful reunion." Ev is a member of the Committee, and we appreciate his help. **Don Way**, also a member of the Committee, writes "Barbara and I thought the Reunion was swell and enjoyed it immensely." **Rus Palmer** writes "It was a splendid reunion and enjoyed every moment of it." **Lou Grayson** writes "We both feel that the Class owes the Committee a great deal for a fine job of handling all the many details of the arrangements." **Bob MacMullin** sent me a two page article written by his wife Olive. It reports on the reunion in a most interesting vein and while I cannot put it in the notes because of space I quote one paragraph, "To add to our pleasure the Alumni Association assigned to us a senior student, just graduated, to act as hostess and guide, and to bridge the 60-year gap between past and present. Her name was Brenda Hambelton, a chemical engineer! She was a very competent and charming person." In signing off this time may I ask each of you to write me a few or many words about yourself; your classmates are interested as I gathered at our reunion. — **Bill Langille**, Secretary, Box 144, Gladstone, NJ 07934

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Buck Clark writes that the first time he missed one of our reunions was 24 years ago when their son was married — so next year it'll be the son's 25th wedding anniversary. Their daughter cele-

brated hers this year. "In spite of all this," says Buck, "Mary and I will plan to attend the 60th in June." We expect you to be there, too. Put down the dates — Thursday, June 5 for the Pops; Friday, June 6 for Technology Day and our special Class Banquet. We'll be sending you more details very shortly.

Don Severance thoughtfully sends a copy of the *Bulletin of the Education Council* containing the following good news about our classmate from Beaumont, Texas — good old **George Morgan**. George is considered the dean of educational counselors, a Bronze Beaver winner, and a driving force for M.I.T. in the state of Texas. He founded the Texas Metal Works which manufactures steel casings — some of which have gone to the moon. George visits the schools in his area every year. He talks eloquently about M.I.T. and does an outstanding job of encouraging minority applicants. We salute you, George, for a job well done and for contributing so much of value to your alma mater.

Some bits of wisdom from the same *Bulletin* that bear repeating: *Law of Innovation* — If you want a track team to win the high jump, you find one person who can jump seven feet, not seven people who can jump one foot. . . . Entropy has us outnumbered. . . . If it works, don't fix it. . . . *First Law of Opposition* — If you push something hard enough, it will fall over. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, MA 01890

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Our 60th Reunion is still more than a year-and-a-half away, but Reunion Chairman **Don Morse** is already planning for the event. He has added **Chesterton Knight**, **Edmund MacDonald** and **Frank Whelan** to his committee. Any member of the committee welcomes suggestions that will make this reunion a memorable affair.

The Public Library in Needham, Mass., had as its June exhibitor **Albert Calvert** of the Needham Art Association. Though graduate of no formal art school, he has been painting for 50 years. He began as an antique tray decorator and later studied oriental painting in Hawaii. The exhibit included a colorful abstract full panel, several paintings in the Chinese manner, pen and ink drawings and a still life in oil.

My West Coast correspondent **Grant Miner** writes that he has been winding up his work with the Zenitaka Corp. He is still keeping his hand in the contracting game, though — he's been hired to ride herd on the building of a $250,000 house in San Carlos this summer.

Class Historian **Bob Miller** reports that he attended an M.I.T. luncheon on June 14 at the Yankee Fisherman in Orleans, Mass. Other '21ers at the luncheon were **Al Lloyd** and **Whitney Wetherell**. The Millers were spending their usual four weeks in June at their West Chatham cottage and planned to be back there again in September. Al and Emma Lloyd visited them briefly in West Chatham — "both in good health," says Bob.

A note from **Helier Rodriguez** tells about last March's Mexican Fiesta. "On March 13 we flew to Mexico and were welcomed next morning at 5:00 a.m. in our 21st-floor bedroom in the Maria Isabel Sheraton with a seismic greeting of sliding beds and jingling ornamental glass in the hanging lamp, swinging at a higher frequency than the building, which we thought was going down at the next oscillation. The amplitude of vibrations at that height was impressive but fortunately the building stood up. We flew with the M.I.T. group to Oaxaca, a typical colonial city, and from there west by bus to interesting and well-kept Indian ruins of large size, built before the time of Christ. Back in Mexico City, Graciala and I stayed with Conchita Lobdell and went to visit **Viviano Valdes** who had just come home for the hospital — weak, but in good spirits."

Thanks to **Don Morse**, I received an obituary for **John B. Mattson** of Winthrop, Mass., who died on July 18. In World War I, John served in the army. During his career, he developed technology crucial to the manufacture of storage batteries. He earned a law degree at Northwestern University. He was active in the Winthrop Improvement and Historical Association. John was a former honorary vice consul of Finland and also chief title examiner for the Massachusetts Land Court. Those who attended our 55th Reunion will remember his entertaining in verse and music at our class banquet, and tootling on his euphonium during our Boston Harbor trip. The sympathy of the class goes to his wife Elma.

In last month's column we reported briefly the death of **Ralph M. Shaw, Jr.** Here is more information. Rufe entered M.I.T. as a junior after getting an A.B. degree at Yale. For three years he roomed with **Ralph Wetsten**. Ten years after graduation, Rufe was working on a development known as "fog vision," using infrared light. His neighbor, Dr. Grimes, chief engineer of Philco, told him if this could be done with infrared, it could be done with radio. They built a set in the basement of Dr. Grimes's home, using Mrs. Grimes's frying pan as a reflector, and a cardboard screen provided by Rufe, coated with luminious zinc sulphide. Said Rufe, "It worked and this was the first creation of radar. A patent was issued to Grimes, assigned to Philco, and Grimes was flown to England. It won the Battle of Britain." Another story Rufe loved to tell was of taking a course under Vannevar Bush, who said on numerous occasions that he was the dumbest student ever. Twenty years later, during World War II, he stopped in to see Dr. Bush in Washington. He told his secretary to tell Dr. Bush that his dumbest student would like to pay his respects. The secretary returned and said, "Mr. Shaw, won't you step in?" — **Sumner Hayward**, Secretary, 224 Richard Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, Lyon Associates, 453 South Spring St., Los Angeles, CA 90013

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Here's hoping that our Classmates have had a marvelous summer including golf, travel and just plain relaxation. . . .

Our Florida Club in Palm Beach County has reported a most successful year with 100 per cent attendance from **Frank Kurtz**, **Milton Manshel**, **Frank Rickers** and **Ted Riegel**. Milt has written that the Class of '22 has six members out of the total membership of sixty-one. They are all happy and active in the Palm Beach area. . . . During a meeting of the Fellows of the Academy of Electrical Contracting at the Greenbrier in West Virginia, your Secretary and Dorothy met Don and Ruth Close of Seattle who gave us good reports of the continued activities of Katherine and **Horace (Mac) McCurdy**. It's always great to hear good news about friends from their area.

We have indirect news that Louise and **Don Carpenter** left their summer home at West Chop for a vacation trip to Alaska. This interesting type of trip has become extremely popular in the summer. Close views of glaciers are really thrilling. . . . Our news from the 1922 Career Development Fund, acknowledged by President Wiesner, has been encouraging and complimentary. . . . We are sorry to report our loss last October of **Bartow Van Ness, Jr.**, of Baltimore Md. . . . The sympathy of our Class is also extended to the family of **Clyde A. Benson** of Winthrop who retired some years ago from the Garden State Paper Co. in New Jersey.

Have a marvelous fall, and get prepared for a delightful winter of fun and games and relaxation. — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, NY 14203; **Oscar Horovitz**, Assistant Secretary, 3301 S. Course Dr., Pompano Beach, FL 33060

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Your secretary-treasurer inherited from **Tom Rounds** 61 black and white snapshots taken at the R.O.T.C. summer camp at Fort Monroe, Va., in 1921 or 1922. The pictures were given by Kenneth G. Merriam, '22 (reason unexplained) in 1975. Presumably they relate to Class of 1923 attendees. The pictures range in size and have no identifications. Unfortunately Ken died in 1977. The intention is to offer the pictures to the Institute's Historical Collections, but they would be more useful and interesting if accompanied by some identifications, descriptions, or comments. Any classmate who attended the 1921 or 1922 R.O.T.C. summer camp and would be interested in seeing the pictures for that purpose may borrow them upon request. — **Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

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The long-lost **George Parker** has surfaced only two blocks from the Exeter Inn. He has had health problems, so could not attend our 55th, but writes, "Give my very best to all the good pals of '24." His progeny expanded to a remarkable thirty-four and he remains near to many, managing two small hearing aid offices. . . . **Ed Moll** has advised those who attended the 55th at Exeter, N.H., that group pictures are available. The 8" x 10" is recommended at $10. Checks should be sent to Ed Moll, Box 261, Sunapee, N.H. 03782. A good opportunity for other classmates to try to identify old friends.

Ray S. Hamilton passed away in November, 1978, at Wirtz, Va. "Ham" was from Missouri and gained an A.B. from Westminster College before his S.B. in mechanical engineering at the Institute. His entire career was with Union Carbide. . . . We have word from Belle Tagart Britt, wife of **Ed Britt**, that he died suddenly of a coronary July 12 in Jenkintown, Penn. He was president of Kennedy & Britt Wool Dyers, a firm founded by his grandfather, joining them after earning his degree in chemical engineering. He was a World War I veteran and active in several civic organizations.

Luisa and **Nish Cornish** wrote a very complimentary letter to **Frank Shaw** and **Ed Moll** indicating their pleasure with the 55th Reunion's easy-going agenda. They suggest a mini-reunion in two or three years as a warm-up for our 60th. Nish contributed to the balance of trade with Mexico by his generous distribution of serapes and then bought two boxes of "Grape Nuts" to take home. Your scrivener suggests that toasted cut-up jumping beans would make a lively substitute.

Don Moore reportedly took five weeks in the Orient, recently, partly to visit his tailor, Won Long Pant, in Hong Kong about some suits. — **Russel W. Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, Co-Secretary, 8 Pilgrim Rd., Waban, MA 02168

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The dates for our 55th Reunion in 1980 have not as yet been announced but since Tech Night at Pops will be Thursday, June 5, followed by Technology Day on Friday, June 6, this should provide sufficient information so that you can begin to reserve time for the Reunion.

Kamy Kametani wrote from Japan at the time of President Carter's visit there and mentions that his visit provided the biggest news at the time. Kamy informs us that the **Arthur Odegards** celebrated their golden wedding anniversary on May 19 in Melrose, Mass. Kamy seems to feel we should be reporting more such anniversaries of classmates.

Our classmate **Chia-Yang Shih** hasn't been heard from for many years but the July 11, 1979, issue of *Tech Talk* carried his picture. He is a professor at Tsing Hua University in Peking and was pictured with Frank Urbanowski, director of the M.I.T. Press, on a recent visit to China. It is nice to learn that he is alive and well. — **F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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It has been a custom (or habit) to report deaths at the end of the notes. Let's change for this month.

I'm still getting the needle for reporting **Bob Glidden** dead when he was very much alive. **John Longyear** writes: "I can vouch for the authenticity of the enclosed obituary but I wonder how the report on Bob Glidden ever got started." The obituary sent by John is that of **David M. Sutter**, founder and president of St. Clair Chores National Bank, who died on the last day of June. Dave started the bank 40 years ago and was connected with it ever since. He was 75 (the median age for most of us).

Jim Banford died on June 5. His wife Pat wrote with information on Jim's life, which was centered in Reading, Penn. — the city, its newspaper and his family drug firm. Jim was always active in civic affairs and at the time of our 25th Reunion he was mayor of Reading. Jim surely left his stamp on the community. . . . **Bob Rogers** sends this letter: "Since you have perhaps not had word from elsewhere, I enclose a clipping recently sent me by **Ted Soo-Hoo**. It's sad news, for it means that we now number one less — **Ted Norton** died June 8 of leukemia. He was a retired marine engineer for the Navy. I was mighty fond of Ted Norton. From our undergraduate days, one remembers his even temper, lack of rancor, easy sociability, all overlying a basis of determination and diligent scholastic work. I've written his wife, whom I met for the only time at the luncheon during our 50th Reunion." To the widows and families of these three classmates we extend the warm feelings of the Class of '26.

While laid up a few months ago we received this letter from **I. Austin Kelly III**: "I've been in correspondence with **Jim Offutt** concerning some rare books that he has given to M.I.T. They were very pleased. Perhaps you could include in your notes that M.I.T. would be very grateful to receive any rare books from our classmates. As you know, some years ago I was appointed as the Curator of Rare Books at the M.I.T. library, so if they write to me, I'll be glad to hear from them. I find myself more and more taking an interest in M.I.T. as I grow older. I'm now in the group that are collecting memorabilia for M.I.T., the father of the Humanities Department, which I've become very interested in and set up an endowment, the Council of Fine Arts and, as I said, the Curator of Rare Books, beside being on the Sailing Committee and for the third term being asked to be on the Development Committee. I've been on the Visiting Committee for the Humanities and the library and also was awarded the Bronze Beaver. My spare time I spend as chairman of the board of the Institute of World Affairs, a 52-year-old organization devoting its time to a better understanding among the nations of the world."

We've received word from **Jay Goldberg** bringing us up to date on his activities. "I believe that I am one of the few members of our class who is still working," Jay writes. "Sylvia tells me retirement age has been moved up to 85 and I hope I can make it. Have not been as busy as I would like during the past year, but continue to get to the office every morning and put in almost a full day. Doing very little "consulting," but am still publishing my *Textracts* (a monthly summary of domestic and foreign textile news and technology) and conducting classes in my private "Capsule Course in Textiles." Other than that, I still testify as an expert witness in fabric flammability cases, occasional patent litigation and textile arbitrations. We attended our first Fiesta of the M.I.T. Club of Mexico — six days in Mexico City and Oaxaca — and enjoyed every minute of it. Our Mexican friends did a terrific job and we can well be proud of our active and loyal alumni south of the border. I thought I would be the oldest alumnus (proudly flaunting my red jacket) — but there were several from earlier classes! Due credit, too, to our Alumni office at Tech for so much time and effort."

As a result of the February, 1978, storm that clobbered us, Pigeon Cove harbor is being beautified but not intentionally. Somehow the town obtained a large amount of money to rebuild the sea walls. The main wall is being put back together with a huge crane on a barge moored alongside my tiny sailoat and the crane is powered by a steam engine. What a pleasure to hear the almost silent power of that engine from an era we all remember and which may — one hopes — be revived. The real beautification is the 100-foot jetty that is being put back together by two men operating a conventional crane with the skill of sculptors. (It took six local "experts" to do the same kind of work with a crane on our wall last year.) The crane bucket picks up a jagged two-ton stone and fits it into the wall as it grows with only an occasional blow from a sledge hammer to make it fit. Magically an absolutely level wall evolves flat on top with a uniform slope on front and back. And with all its beauty it adds safety and protection should the seas become rampant again. We must also mention that, in addition to our recent story about Andre the seal we now have a 40-foot humpback whale in our front yard. For two weeks he has been spouting and flipping his huge tail as close as a quarter mile from shore. We have seen him twice and some of our sailing friends have been too close for comfort. — **George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, MA 01966

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More sad news this month. **Joe Melhado** died July 29 after an heroic struggle. I had a very good visit with Joe and Marian in their home on June 5. Joe was in quite good spirits and doing very well in getting around. Marion was driving him into New York every few days for chemotherapy. They had just returned from visiting children and grandchildren in Atlanta. Joe was looking forward to the concert in his honor which was so well described in his daughter-in-law Ruth's notes last month. Joe served the Class long and faithfully as secretary. We shall all miss him greatly. I have asked **Joe Burley**, our class historian, to take the job, and he has agreed. I have great confidence that he will do well. Remember the fine class history he put together for the 50th Reunion? So, please send material for class notes to **Joseph C. Burley**, 5 Hutchinson St., Milton, MA 02187.

We have just learned from his wife Ann that **Joe Harris** died in Mystic, Conn., on July 19. He had a kidney failure more than two years ago and had been on dialysis since then. In Ann's words: "He fought a gradually losing battle. His was a brave and uncomplaining fight. As his capacities diminished, he managed to find pleasure in what was left to him." Joe was secretary of the Class for 30 years. He was with Shell Oil Co. for 32 years, retiring in 1963. After retirement Joe kept busy as an instructor at Mitchell College (New London, Conn.) and with S.C.O.R.E., of which he was vice president of the Eastern Connecticut Chapter in 1974. This is another great loss to the class and to his many friends.

Word has also been received of the death on June 12 of **Francis L. Ford** at his home in Fairlawn, N.J. He retired in 1967 from Petro Chemical Co., having also been a consulting engineer for Foster Wheeler and formerly with M. W. Kellog Co.

Richard E. "Steam" Harrison is back in Shrewsbury, Mass., after his twelfth winter in Longboat Key, Fla. He would like to see any classmates who are "wandering around the West coast of Florida." . . . **Middleton L. Perry, Jr.**, reports that he retired in December, 1973, after nearly 38 years with Black & Veatch, consulting engineers of Kansas City, Mo., and 7 earlier years with Kansas Power and Light in Topeka. He has a son in St. Louis and a daughter in Longview, Texas.

Some weeks ago **Pub Whittier** wrote a note of sympathy to **Joe Melhado** and added: "Ruth and I pursue the even tenor of our ways and fortunately are enjoying good health. Our three sons and their families live away from us in Virginia, Indiana, and the Philippines. We have the unique misfortune of having a daughter-in-law and grandson whom we have seen only in pictures. In time we hope to correct that deficiency." . . . **Russ Westerhoff** says that his wife Katharine has recovered well from a mastectomy in January. Last fall he passed his examinations for amateur radio operator and has his license (call WA2PIR). Their younger daughter is studying for the ministry, has completed two years at Andover-Newton Seminary and goes this fall to Princeton Seminary tor two more years. — **Harold W. Fisher**, President, P.O. Box 1792, Duxbury, MA 02332

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We were pleased to have a letter from **Tom Larson** but sorry to learn that he had just been hospitalized for 19 days and two surgical operations. The problem was discovered at Massachusetts General Hospital in Boston but Tom chose to have the surgery done at University Hospital in Ann Arbor, Mich., so that he could stay with his daughter and son-in-law (an M.D.). At the time of his writing Tom had just left the hospital but still has a few weeks of medical attention to go. He reported himself as feeling okay and just resting and relaxing. Tom is chairman of the Scoring Committee for the U.S. Open Golf Championship of 1980 to be held at Baltusrol Gold Club, Springfield, N.J.

One of our most faithful of corrresponding couples, Mary and **Max Parshall**, report on their summer activities: Except for a bout with the flu last spring Mary has been well and very busy with her music. She is still teaching piano (to mature and older women) and gives occasional concerts to local groups. Max records some of them. For his own part Max still plays his viol although poor vision makes it impossible for him to read music. Max wrote to **Henry LaCroix** a short while ago and received a nice letter in reply. The Parshalls had a good garden this year despite a cold dry winter and a hot dry summer. Only diligent use of the watering hose allowed success.

News clippings from the *Evening Bulletin* and the *Journal*, both of Providence, R.I., inform us that **A. Wentworth Erickson** has been appointed to a three-year term as chairman of the Barrington College Board of Trustees. Bill has been a member of that board since 1974. He is also vice-chairman of the board of trustees for Wentworth Institute in Boston.

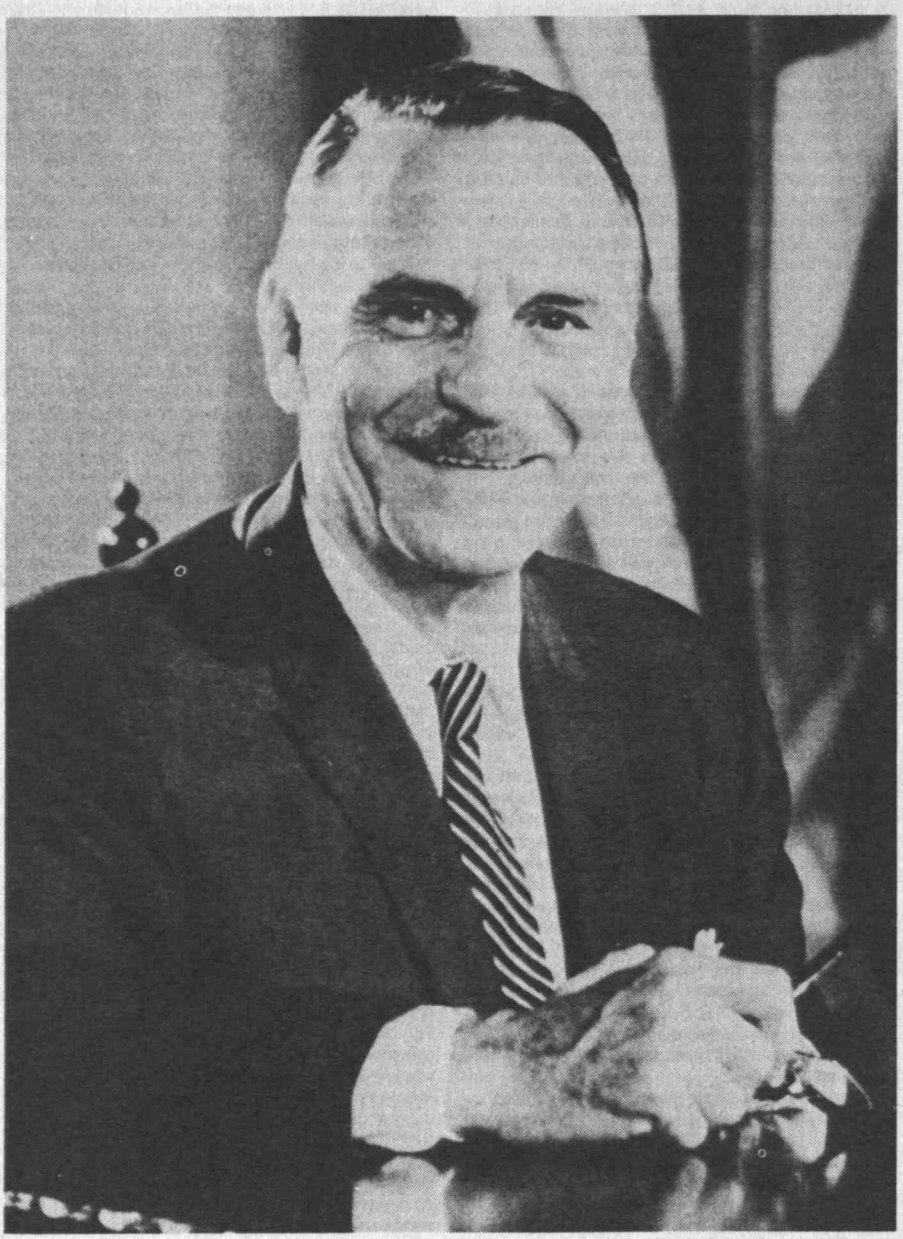
With much justifiable pride, **George Chatfield** wrote to tell us that his father had just been inducted posthumously into the Minnesota Inventors' Hall of Fame in recognition of achievements in America's knitting industry and as evidenced by some 38 patents in that field. The award was made June 8 at Redwood Fall, Minn., and George was on hand to receive the plaque from the U.S. Commissioner of Patents. George's dad was one of 14 children, attended school only to the age of 14, was self-educated thereafter, rose to prominence in his business world and lived to the age of 98. George himself has finally taken a halfway retirement status by selling his radio stations and Muzak agency but retaining his newspaper, the Montachusett *Review*. Now he and Marie have more time to enjoy life. In June the Chatfields met with Louise and **John Reynders** for a pleasant evening out at a dining spot in Holden, Mass. George wore his full 50th Reunion outfit for the occasion. He says that the Reynders appear to be well and now spend their winters in Sea Island, Ga.

Ted Hubbuch wrote us a letter concerning an interesting project he is fostering at the University of North Alabama. Along with his letter he enclosed some newspaper clippings describing the project. It relates to the production of alcohol from newspaper, wood chips, and other waste cellulosic materials. Ted's process is designed to produce an alcohol suitable for use in gasohol and a byproduct residue usable as fertilizer. The project has the financial support of the Tennessee Valley Authority. Ted was professor of chemistry at U.N.A. prior to retirement. It is obvious that Ted and Myrt are still going strong.

The death of Pops Concert Conductor, Arthur Fiedler, reminds us that the popular Maestro gave his 50th and last M.I.T. Pops Concert at the time of our 50th Class Reunion last year. **Al Gracia** attended both the 1928 and 1978 concerts and, with the help of Dr. Wiesner, had his program copies for both occasions autographed by Mr. Fiedler. This rare pair of programs (fifty years apart) has been presented to the M.I.T. Historical

The Why of Life

by Luis A. Ferre, '24



Luis A. Ferre, '24, has had at least three careers: as successful industrialist in Puerto Rico; as a political leader of that territory, of which he is a former governor and now president of the Senate; and as a patron of the arts. This article is adapted from his address as its chairman to the Council for the Arts at M.I.T. in October 1978.

In an interview not long before his death, Andre Malraux made the following transcendental observation. Asked what he believed was the problem of contemporary civilization, he answered that our civilization was the first to ignore the meaning of life: if a man in the streets were asked today why the human race lived on earth, said Malraux, he would answer simply: "I don't know" — and probably add: ". . . and I don't care." Malraux proposed that the root of this ambivalence lies in our scientific age — an age in which the intellectual and moral development of man as it was known to him in the past has ceased to interest us and the only true intellectual activity is held to be the rational method of scientific investigation.

This is something unheard of in the history of civilization.

From earliest time, man has tried to understand his relationship with the universe and the why of his existence, at first using magic and later religious and philosophic systems. It has only been at present that man has lost a general interest in the transcendental questions of life, dedicating himself to furthering the inquiry of science and technology.

But for all its power over the purely physical world, science fails to give man a sense of direction in the concepts of good and evil because it is neutral and lacks a perspective of values. It is for this reason that man is bewildered today by the conflicts that threaten him — conflicts which could very well end up in his destruction. He has no moral compass to guide his life and his behavior.

The Universality of Beauty in Life

Reflecting upon this problem, I put to myself the following question: Is there not something common to all human beings that may point to the why of life? And I said to myself: As it usually happens, the truth is so obvious it can't be seen. Yes, there is a common element to all human activity: the creation of beauty.

If we observe the difference between the inanimate and the animate universe, we discover that beauty is born with life. If there is no life, there is no beauty for the simple reason that beauty is only perceived through the senses. If there is no eye, there are no colors; color is the result of the partial absorption of radiant solar energy reflecting from an object and producing that which we call color in the eye-brain system. The radiant energy of the sun by itself has no color: it is not even white; it is simply undulating energy. If there is no ear, there is no sound. There is only energy in motion, represented by waves that move the air, or whatever means of transmission exists, in a rhythmic fashion. Sound exists only in the ear-brain system of a living being.

It is curious that sound can be both beautiful and disagreeable to the ear. Pythagoras discovered that strings under

Beauty is the universal principle which ties together all the phenomena of life and evolution.

tension vibrate together and emit a harmonic sound if their lengths are related in simple numerical proportions. The numerical relation that produces harmonic sound constitutes a mathematical form, and its discovery was — in the opinion of the great physicist Heisenberg — one of the greatest discoveries of the human race. In this way, a mathematical form — in this particular case, the relation between whole numbers — results in what we perceive as beauty.

This discovery was a huge step towards a new form of thought: the concept of formal order as a basic principle of reality — a very powerful idea out of which all modern science has grown. According to Pythagoras and later Plato, the confused stimuli that affect our senses can be understood as long as they are ordered according to form which can be expressed in mathematical structure.

So we discover not only that beauty originates in life and is absent where there is no life but that it is the basis of that human quest we call science, which rests on mathematical order. Beauty is, therefore, the universal principle which ties together all the vital phenomena of human understanding.

The importance of beauty has been perceived equally by philosophers, scientists and artists. The late Vannevar Bush, '16, the renowned scientist and pioneer of the electronic computer, once observed: "Do birds sing for the love of singing? *I think* so. The complexity of their trills is much greater than would be required to be recognized or to protect the area to which they lay claim." The mystic Plotinus held a similar opinon: "Beauty is that interior light which we discern in natural phenomena, the eternal splendor which surrounds beings."

An Oasis of Beauty in a Hostile Universe

Consider for a moment the universe which surrounds us. Is not beauty central to its evolution? Our universe is hostile to life as we know it. It is a universe of emptiness; its suns are huge ovens where hydrogen is the combustile matter, ranging widely in temperature and density, sometimes exploding, at other times contracting to such density that not even light can escape the pull of gravity.

Yet the ordered conditions that make life possible converged upon the earth: the sun is a certain size and is a certain distance from the earth; water was produced in sufficient quantities to create life-giving seas; oxygen and nitrogen were produced in just the proportions adequate to sustain life. And as soon as life was born, ascending evolution began to create the forms of beauty we know today: corals, fish adorned in bright designs and colors; birds of beautiful feathers and harmonious song; flowers, with their infinite variety and beauty; and finally man, the crown of evolution, capable of expressing beauty in poetry, painting, music, sculpture. Beauty is, indeed, a human universal, for it is not merely an obsession of highly civilized peoples; all cultures have given artistic form to their artifacts.

When I contemplate this panorama of the universe and when I consider the patterns of order that seem to govern both the infinitely large and the infinitesimally small, I ask myself: Can all this be the product of mere chance? Is it possible that human life, in which the innumerable forms of beauty reach their evolutionary culmination, is unrelated to universal order?

The Transcendence of Aesthetic Values

My answer is no. Life must have a transcendental purpose.

I believe that the great crisis of our civilization has come about because we have ceased to heed the voice of evolution, which made beauty something intimately related to life itself. We have forgotten the transcendence of aesthetic values, seeing them as useless "frills" and consigning them to the atheneum of the elite. We have devoted ourselves to playing with the tools we ourselves have created at the expense of the dreams of our spirit. Don Quixote said it for us: "The beauty of man is to be found in dreams."

If we lose our aesthetic values, we will have lost our perspective of life. In this view art is an essential element of life itself, and its teaching is the most effective discipline to make man aware of his intellect and senses.

Art can point out the way, but the creating of beauty is just a step towards the culmination of the evolution of the human race — a step towards the development of sensibility, harmony and understanding in the search for ethical values and the development of virtue.

Man needs a compass which will make it possible for him to choose between good and evil. This compass is his conscience, the peak of human evolution. For if life were governed strictly by instinct, which admits no moral sense of good and evil, human society would find it impossible to strive for peace and harmony.

Let me sum up with a personal credo: I believe that the primary purpose of life is reproduction; that its ulterior purpose is the creation of beauty; and that its transcendental purpose is the creation of ethical values in a social structure through understanding and love, where human conscience is the guiding principle. Contrary to what Malraux believed, I maintain that today, thanks *to* the extraordinary developments of science, we can better understand and contemplate with profound respect the phenomena of life. We can come to comprehend its purpose and search for the means that will permit us to join our efforts towards the pursuit of its transcendental end.

Collections.

Jim Donovan is still our best reporter — he is our busiest intraclass correspondent. Much of what follows has come through Jim's office: **George Palo** wrote to say that he and Anne were planning a three week vacation trip. Two of the weeks would be spent fishing in Minnesota and visiting relatives and friends there and nearby. The Palos also hope to be at the Alumni Officers Conference in September. . . . **Noel Olmstead** wrote mostly on a matter of business but did state that he and Mary have been spared any serious illness and have been enjoying retirement. . . . Josephine (Mrs. **Edward M.) Shiepe** said in her letter how much the 50th Reunion had meant to her and especially to Ed. It was only sheer courage and determination that enabled him to overcome his physical disability and to attend. The occasion had such meaning for them that both were grateful to the time of Ed's death. We certainly hope that Jo will continue her warm association with the Class.

With deep regret we must report the deaths of two classmates: Colonel **Anthony Fleming** died on May 20, 1979. We received letters from both his daughter Patricia and his son James. Patricia said that her father had thoroughly enjoyed the Reunion last year and that she had joined him 10 years earlier for some of the activities during the 40th. For most of his career Tony was an engineer with the Army Corps of Engineers from which he retired in 1962 as colonel. In later years he did consulting work as an industrial engineer. He was widowed and had two sons and two daughters. . . . **Walter K. Grimwood** died on February 21, 1979. In talking with his wife, Ruth, we learned that Walter had been in good health and his death was unexpected. Walter's professional career was with Eastman Kodak Co. As senior research associate he was concerned with the development of sound-on-film and later undertook the improvement of sound track tape. He was the author of various papers and patents on these subjects. Walter retired in 1971 after 43 years of service with his company. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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As a result of the recent start of a dialogue between the U.S. and the People's Republic of China, a letter comes from Professor **Chung-Foy Yee** of Canton, China, addressed to the President of M.I.T. Here are some excerpts: "It may be of some interest to you to hear from an old alumnus of M.I.T. As I look back to my undergraduate days half a century ago, I have many pleasant memories of the Institute and your country. Though I am what is considered at an old age, I still take part in the training of graduate students doing research here at the South China Institute of Engineering. After a long separation between our two countries, I am sure that we Chinese have a lot to learn from the American people. If my memory serves me right, there are class reunions held at the M.I.T. campus. Since it has been 50 years since I received my S.B. degree in 1929, is there a reunion scheduled for our Class? If so, I should like to attend and renew my friendships with my old classmates and visit the Institute." Apparently Professor Chung-Foy Yee was unable to attend, since he was not present at the Reunion even though the information was sent to him.

Professor **Maurice E. Barker** sends this note: "This is my first letter since graduation in 1929. I was an Army (Chemical Corps) student at M.I.T. in the advanced engineering course. After receiving my Sc.D. in 1930, I went back to Edgewood Arsenal as head of the Research Division. I also did field and troop duty with the 2nd Division. Went back to Washington, D.C., as chief of Technical Division, Army Chemical Corps. During World War II, I became colonel in 1941 and saw action in North Africa, Italy and Okinawa, and retired in 1948. At the University of Arkansas I was appointed as professor of chemical engineering and director of the Institute of Science and Technology until my retirement in 1961, at which time I became a professor emeritus and consultant on chemical projects. I have 16 U.S. patents including two on activated charcoal and one on muzzle brakes for cannon. I have decorations from France, Italy, Finland and the United States. Thanks for the Birthday Greeting — I will be 85 years old on May 20."

Paul S. Baker sent this letter to **Jim Fahey**, general chairman of our 50th Reunion: "I am sorry that we have to cancel out of the Reunion activities, as we found yesterday that Kay is scheduled to have a series of tests at the Nelson Clinic of the Medical College of Virginia in Richmond. She had a T.I.A. episode earlier this month, from which she has fully recovered. Under the circumstances we are sorry we will not be with you at the Cape nor at Cambridge. We enjoyed ourselves very much at the 45th Reunion, and were looking forward to the 50th." . . . A brief note from **George D. Rogers** indicated that he would not be able to attend the 50th Reunion, as he had a conflict — he was due to attend the 60th anniversary of his graduation from West Point. . . . **Edward C. Roche** wrote, "Many thanks for your birthday greetings, which tell me that I am a year older and 'time marches on.' I am not sure if we are going to make the 50th Reunion, but we will try." Ed and his wife Dorothy did attend the M.I.T. campus activities and my wife Helen and I had the pleasure of having breakfast with them at the Student Center on Friday morning.

Murry M. Brimberg writes, "We have just returned from a six-week visit to Israel where our daughter and her family are spending a sabbatical year at the Weizmann Institute of Science, doing research in immunology and hematology. The grandchildren are enjoying attending school there and are learning to speak Hebrew fluently." Murry and Mary were present at the 50th Reunion — at Chatham and on campus. . . . **Marshall S. David** reports that he attended the N.I.D.A. conference at Hersey Park in September of last year and toured the Gettysburg area and the Amish country. He spent several days at his son's home in Delaware. He was at our Reunion with his wife Dorothy. . . . **Jarvis M. Hazard** sent a brief note: "I have been busy at work for the past 50 years, and today is no exception. I will be missing our 50th Reunion due to the present workload, which apparently has no end to it."

Brigadier General **James E. Howarth** has been retired from the Marine Corps since 1967. He is engaged in the sale of real estate, currently with Carriage House Associates, Realtors, in Arlington, Va. . . . **Edwin H. Perkins** writes, "I am finding a lot of satisfaction and pleasure in my retirement years. I am chaplain of my Masonic lodge, treasurer of my Eastern Star chapter, and commander of the D18 (Essex County) U.S. Power Squadron. I am very grateful for pensions that I receive from Bell Laboratories, U.S. Air Force, and Social Security, which enable me to do all these things." . . . **Thomas W. McCue** is continuing with his adult education program at B.U. in economics and finance. He is also active in his sales business, dealing with such commodities as coal and steel. Tom was present at the 50th Reunion. . . . **Richard E. Bolton** of Canada wrote, "I retired at age 72 from the practice of architecture. However, I am still chairman of the Architectural and Planning Commission of the city of Westmount. As an elder statesman, I am listened to with politeness, if not with interest. We have just returned from our annual visit to Sanibel Island, Fla. I am looking forward to the launching of my sailboat in about a month's time. I regret to say that I shall not be able to attend the 50th Reunion due to family arrangements. Many thanks for the Birthday Greetings." Richards' hobbies include sailing, heraldry, painting and model railways.

A letter sent to the Alumni Association from Robert W. Carr '27, contains sad tidings concerning his brother, **J. Gordon Carr**. The letter states that Gordon had a massive stroke in November, 1976, which left him completely paralyzed on his right side and almost without speech (except for a few simple words). I know Gordon from our undergraduate years — he always possessed an exceptionally outgoing and friendly personality. Each year, he responded to my Birthday Greetings by sending news items about his activities, so it was a puzzle to me that I had not heard from him for the past few years. His illness explains that. He was a successful architect, heading his own firm, J. Gordon and Associates. In the most recent note that I received, probably just before his illness, he stated that although he was still active in his professional work he had reduced his workload. He also said he was devoting a great deal more time to his water-color painting — he had a number of "one-artist" exhibitions in the New York City area (where his business was located). One of his paintings was featured on a well-known insurance company calendar a few years ago. Now he is in a nursing home, Nathaniel Wetherill Hospital, Parsonage Rd., Greenwich, Conn. If you happen to be in that vicinity, your personal visits and your "get-well" cards and notes will certainly boost his morale. — **Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174, (617) 643-8364, (603) 926-5363

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Years ago, it didn't bother me so much but now as we approach our 50th reunion, one of the saddest things your class secretaries have to do is to report the death of some of our classmates. This month the Alumni Association reported the death of **Harland A. Danforth, Jr.**, on February 1, 1979; the death of **Gerald A. Benoit** on July 8, 1978; and the death of Captain **J. Thomas Howard** on May 31, 1978. No additional details were given and the Class of 1931 extends their deepest sympathy to their families.

If it hadn't been for **John Swanton**, your assistant class secretary, that would have been just about all the news I have for this month other than to say that **Fred Elser** and I keep trying to maintain our ham schedule Sunday nights at 10:00 P.M. our time, on 14,004 kHz. Sometimes we are successful, other times we just can't get through. Thanks to John, we have the following: **Phil Donely** has retired from NASA, is still married, travels the Caribbean and enjoys golf and fishing. I was glad to hear that he enjoys the class notes but sorry to hear that he doesn't see any class members.

Parker Dunn has two children and two grandchildren, is 50 per cent retired, hopes to attend the 50th reunion, is still married and likes tennis, hiking, reading and fishing. . . . **Leon Fraikin** has three children and five grandchildren, is still married, likes gardening and golf, and is director of "Foundations." . . . **Bob Gardner** retired in 1971, has one child and two grandchildren. He is a widower and lives alone in the same place he bought in 1949. He has a 20' sailboat and his last travel was to the 1977 America's cup on New Shoreham. . . . **Leo Green**'s new address is 73-11 34th Ave., Jackson Heights, N.Y., 11372. He's been married 40 years and is still practicing full time orthopoedic surgery plus being president of the board of directors of the hospital. He hopes to see all of us in 1981 and hobbies include photography, ham radio (how about a schedule Leo?) and plenty of travel. . . . **Henry Grinsfelder** has one child and four grandchildren, is 98 per cent retired and still married. The Township Planning Commission keeps him pretty busy. He takes one or two trips a year, plays tennis several times a week, and is a statistical consultant in economic trends and the stock market. . . . **Chauncy Hamlin** is retired, has two children, and is still married. David, one son, is comptroller of production at M.C.A. University; Harry, the other son, is an actor. Chauncey summers in Muskoko, Ont., and enjoys fishing. He joins the crowd saying that the heat leaves him with no pep.

Pat Harney, who never married, is 50 per cent retired. He is busy maintaining his mother in a Nursing Home and "camping out" at her home in Utica, N.Y. Pat is now a certified consultant and registered as P.E. . . . **Mayer Hyman** is 10 per cent retired, has two children and one grandchild, is still married, collects coins and medals of medical interest and is going to Europe in June before you read these notes. . . . **Sam Jacobson**

has two children, no grandchildren, is retired and still married, plays some golf and winters in Florida. . . . **Mike Kundrath** is still married, has two children and two grandchildren. He is still in real estate and likes wood working, music, travelling, photography and hunting. . . . **Bob Leadbetter** has remarried, has one child and one grandchild, is retired and likes sailing and golf. He visited England in May and will probably take more trips later. Recently, he was in Maine opening his cottage and getting his sailboat ready for the season. . . . **Carrington Mason** says he has two children and two grandchildren, is still married, 2 per cent retired and is a consulting editor for the pipe line industry; executive secretary, Texas Gas Association; president of the board of trustees Brazos; and a distinguished eagle scout.

Bill Metcalf is semi-retired, still happily married and has no children. He is doing research and biomathematical analysis of radical breast cancer survival — also likes to travel. . . . **Sid Milligan** is still married and retired but still working for the Preservation Society of Newport, R.I., between travels to Europe and Bermuda. He likes gardening and taking college courses in genetics, cytology, botany and oceanography. . . . Not much news from **Bill Robinson** except that he is still married, has three children and three grandchildren. — **Edwin S. Worden**, Secretary, P.O Box 1241, Mount Dora, FL 32757; **John Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360

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At the June alumni luncheon I had a chance to have a good talk with **John D. Northup** of Toledo, Ohio, and his wife Ruth. For 40 years he has been with the Owens (Ill.) Glass Co., and for many years he served as vice president and director of engineering — not bad for a Course XV man. He has been in *Who's Who* for over 20 years. Although technically retired, he does considerable consulting work. Their three children all have graduated from prestigious colleges and are leading interesting and creative lives. John's hobbies — outside of his family — are golf, gin, and travel. . . . It was good to see **Harry Johnson** of Columbus, Ohio. He retired from Westinghouse five years ago. Today he does some teaching and consulting in the field of industrial purchasing. Marion and Harry have three children and two grandchildren. They hope to attend the 50th Reunion. Harry is interested in golfing, bowling, history, and economics.

John T. Kelton sends the following letter: "It is with sorrow that I report the death of my fellow townsman, **Frederick W. Green**, in April of this year after a long illness. Fred had retired from the Nash Engineering Co. with which he was prominently associated for a number of years. He had long been very active in M.I.T. alumni matters in Connecticut. In a more pleasant vein, I am still actively involved in the practice of patent law in New York City. My wife and I occasionally get away to travel, as we did this winter to Egypt — a place that one has to see to believe and most pleasantly so."

Jim Harper for many years has been the class chairman for the Maryland, D.C. and Virginia district for our class. He has always been the source of news with his letters. Finally his insidious Parkinson's disease has made it impossible to carry on his duties. His resignation has been given to our President **"Nick" Flatley** who has regretfully accepted it. I'm sure his voice and pen shall still be heard. He favors a reunion in 1980 in Williamsburg, Va.

On June 21, **Thomas R. Smith** was named Iowa Inventor of the Year and awarded a position in the Iowa Inventor Hall of Fame — in his 42 years of creative product design with the Maytag Co., he authored over 250 patents. The award is sponsored by the Des Moines Center of Science and Industry, the Iowa Manufacturers Association and the Iowa Patent Law Association.

It is my sad duty to report to you the following information from the M.I.T. Alumni Records office: **Howard H. Imray, Jr.**, of Naples, Fla., died on November 3, 1978; Colonel **Norman E. Poinier** of Austin, Tex., died on January 19, 1975; **Joseph P. Fahey** of Niagara Falls, N.Y., died on March 30 of this year. If I can get any obituary information I will pass it on. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Quite recently we received note from Don Severance which enclosed a copy of the latest *Bulletin of the Educational Council*, which contains a great write-up about **Francis O. Merchant**: "There are a number of things that are impressive about Fran Merchant, but the one that strikes one most is the degree of respect he commands from those about him. In November he organized one of the most successful central meetings ever, and everyone spoke in tones bordering on reverence of the leadership roles Fran fills. His work with the Council and the secondary schools in his area is now legend, but that must be the natural result of 12 years of continuous, patient, quality service to an area. His interview reports reinforce the image of a sensitive, caring gentleman and a very gentle man."

Early in June we received a short note from **Walt Duncan** saying that he and Janet would soon be attending their 50th Reunion at Phillips Exeter Academy. We replied to Walt that we would enjoy having them call on us for a cocktail — they did just that, and it was most enjoyable. I asked Walt if he would send me the family story for the *Review*, "Janet and I are traveling as much as we wish, and in fact are in the midst of working up the details of a drive through eastern England and Scotland, beginning near the end of September. The only earth-shaking news about the family is that our elder son, H. Scott Duncan by name, started work at M.I.T. on the first of this month as associate director of the Advanced Management Programs of the Sloan School. He was involved in this sort of activity at the University of Hawaii some years ago, and decided to go for a doctorate in anthropology. However, an opportunity opened up at M.I.T. through his former boss in Hawaii and he started here July first. He is a graduate of Dickinson College with his graduate work in anthropology done at U.C.L.A. This is our second Ph.D., the first belonging to our other son, Bruce, who is a professor of German at Dartmouth. Our daughter Susan has a master's degree; Janet has a master's degree; but it shows the relative value of just a bachelor's degree from M.I.T. because I am still the smartest one in the whole family!"

A note comes from **Olavi Viita**: "We sold our home in Braintree in January 1978 and moved down here to the Cape where we had built a second home with retirement in mind. No sooner had we sold the home in Braintree than our daughter, Mimi, who is an architect working in Boston via Smith and Harvard Graduate School of Design, told us she was planning to get married in the near future to her long-time boy friend, Paul Glynn. Topping this off our son, Paul, who had earned himself a Rhodes Scholarship at Harvard and spent three years at Oxford (Balliol College), decided to work in London, and informed us that he was planning to marry the young lady, Rosanna King, he had met at Oxford (St. Anne's College) and was in the process of buying a home in the Barnes section of London." So Mimi was married in nearby Osterville on June 24 and Paul on July 29 in Datchet, Slough, England, in the shadows of Windsor Castle. Marie and Olavi attended both weddings and also enjoyed a week in London and another sightseeing in Paris.

Walt Skees sent a letter to **Ellis Littmann**, with a copy to me. He is devoting a lot of time to doing translations (English to Spanish) on engineering subjects. He is also doing some trouble-shooting in electronic equipment. Further, it turns out that he is a collector of very old books, some 150 years old. Walt also seems to be a Spanish gourmet and he sends me a recipe occasionally.

Some time ago we suggested that there may be some unfortunate classmates who are housebound or worse, and that I would appreciate hearing about such cases so as to encourage more fortunate friends to write or visit them. I mentioned **Henry Kiley** as an example. Now Henry writes me that he is not at all housebound — he did have a bad case of asthma several years ago, but medication, breathing aids, and proper pacing of activity have effected a cure. He says that he and Betty are both quite well. They visit San Francisco and Yorktown, Virginia to visit their sons; also, they make a few visits annually to the Boston area, which fills in their regular schedule rather well. We are pleased to hear that the Kileys are okay.

Dr. **John Sterner** became vice chairman of Cortis Corp., a Florida-based manufacturer of health care products, as of July 1. . . . **John G. Trump**, director of the High Voltage Research Laboratory, at M.I.T., has been inducted as a Fellow of Polytechnic Institute of New York. He lives in Winchester, Mass., and is senior lecturer and professor emeritus of electrical engineering at M.I.T.

Belatedly, Alumni records inform us of the passing of **Arthur T. Mason** of Pittsburgh last November. There are no details available, though I seem to recall that Art was with the Northwestern Life Insurance Co. — **Warren J. Henderson**, Secretary, Fort Rock Farm, Exeter, NH 03833

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As I promised last month, I want to begin with almost a voice from the past. Through the Alumni Office comes the following news from **Ming Li Loh**, who received his S.M. with us in 1934. It pretty much speaks for itself, but it does drive home what the M.I.T. experience meant to some of our foreign students. After many years in the U.S., Mr. Loh in early 1947 went back to Canton, China, and took a job as a professor at the Sun Yat-sen University; he has been in Canton since then. He writes:

"Since the founding of the People's Republic of China I have been a senior professor of the South China Institute of Technology and had been president of that institute before China's cultural revolution. In 1959 I received the invitation from the Alumni Association asking me to attend the reunion for the 25th anniversary of the Class of 1934. But at that time it was inappropriate for me to answer, and the liaison was thus broken off. Now the official diplomatic relationship between U.S. and China has been established, I think it's the time for me to resume our liaison. In fact, I am quite eager to know what is going on in our M.I.T. and how my old classmates or schoolmates are. Would the Alumni Association tell me all about this? I am awaiting eagerly."

After receiving his letter, the Association put Mr. Loh on the list for the *Review*. If any of you remember him and would like to write, his address is: 44 People Back Lane, Teh Ching Road North, Canton, People's Republic of China. Wouldn't it be something if he could make it to our 50th?

While we gain one who seemed lost, unfortunately I also have word of the deaths of two other members of the class — **Warren K. Lewis, Jr.**, of Salem, Va., on April 18 and **Kevin Malone** of Beaverton, Ore., on May 31. I have no other information about them and can only express our sympathy and condolences to their families.

To catch up with more of the Alumni Fund notes: **Neal Carr** wrote, "Retirement on this most southerly and western corner of Florida is great. Active in golf club, racquet club, yacht club, Coast Guard auxiliary, Rotary, and United Church. Fishing interesting but nonproductive — for me, at least." Fortunately, Neal and his wife Petey managed to find their way from that most "southerly and western corner" to Cambridge for our reunion and we had a pleasant time with them.

Christian E. Born had a real choice to make: he wrote, "Glad to still be able to make a contribution to M.I.T. as well as attend my 50th reunion at Dartmouth the week-end of June 7-9, 1979." A conflict like that gives him an excuse, but I hope five years from now our class will get the nod.

A cryptic note that infers some unfortunate

How to Turn U.S. Coal Into U.S. Gasoline

It's time for the U.S. to "put coal on the front burner," says Henry G. McGrath, Jr., '36, of the Energy Systems Planning Division of TRW Inc., Washington, D.C.

And in doing so, he told the Washington Section of the American Institute of Chemical Engineers early this year, we should take a leaf from the South Africans' book by embracing the technology in the SASOL-I and SASOL-II plants for converting coal directly into such valuable petroleum products as gasoline and lubricating oils.

Mr. McGrath's interest in synthetic fuel from coal dates back to his first work on the German Fischer-Tropsch system in the 1940s. Within a decade his company had developed a process called synthol, and he found himself among those assigned to explain its advantages to the South Africans. His boss's instructions, he recalls, were: "Go down there and stay 'til you get the order or get thrown out of the country."

It all worked out well enough. SASOL-I used some of the synthol technology with other German technology to convert low-grade coal from an adjacent mine into hydrogen and carbon monoxide and then react those with catalysts to make gasoline, heavier oils, methane, ethylene, and other chemicals. Typically, just over 60 per cent of the total product comes out as gasoline, ready for consumption — no refining needed.

Convinced by the success of SASOL-I, the South Africans are now building SASOL-II, several times larger. Its cost will be over $2.5 billion, including the new coal mine and the associated chemical plants. But when it's finished South Africa will be able to produce directly from coal 40 per cent of its total gasoline needs.

SASOL-II technology is ready for use in the U.S., where Mr. McGrath predicted a plant to produce 40,000 barrels a day of oil — mostly gasoline — might cost $1.6 billion. He admitted to his A.I.Ch.E. audience that "the creation of a synthetic fuel industry in the U.S. based on coal is no simple problem." But he urged a major effort — "decidedly in the national interest," he said.

trouble comes from **W. Q. Smith** (possibly written by someone in his family, by the signature). It is just, "Still making recovery from bad car accident in August, 1977."

Harry Heiligenthal seems well but just pessimistic when he writes: "The older one gets, the less he sees any progress in solving our problems. Money is not the answer — we are all sail and no rudder."

Eino Jaskelainen is apparently following **Phil Kron**'s schedule. Eino writes, "Retired in 1977 from Kodak as development engineer in consumer products. Spending winters in Florida and summers in the Rochester area. Hobbies are gardening and trailering. Have daughter (a ballet dancer) and son in business, both in the Rochester area."

Finally, **Chet Tudbury** notes "Retiring May 1, 1979, as technical advisor from Thermatool, Inc., Stamford, Conn., and moving to 8622 Hayshed Lane, Columbia, Md. 21045, in mid-May. Will engage in consulting, loafing, and revising *Basis of Induction Heating*." This last reference brings back memories — it wasn't until our junior year that **Eric Isbister** and your writer learned that induction heating was done, not with many turns and few cycles, but with few turns and many cycles. Why didn't Chet tell us then?

One final item: writing before the reunion, **Fred Johnson** included the following about some aspects of his own career: "Over the years, we have moved around a bit having had permanent residences in Massachusetts, Rhode Island, Virginia, North Carolina, Kansas, Florida, Mississippi, California, Georgia, and Texas. It included a stint in the Army overseas during World War II, giving me retirement as a colonel some years ago. We are once again settled in Greenwich, Conn. Kae and I are happy to report our 42nd anniversary this month which produced 42 wonderful years, a daughter, and four grandchildren. Several years ago I became tangled up again in thermodynamics, the same as in Course II, and am now an officer in a fine boiler manufacturing company, working and enjoying it every day." One sad note to report: my long time good friend **Charlie Sheehan** is not in his usual top form. We had a note from his wife Mary saying that it did not look good for the reunion. They have been regulars at our get-togethers, and we for one couple will miss them." — **Robert M. Franklin**, Secretary, P.O. Box 1147 (620 Satucket Rd.), Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20015

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At M.I.T. night at the Pops we sat next to Barbara and **David Terwilliger** where I learned that Dave has spent the last 19 years at Northrup in Norwood following a number of years with Aircraft Armaments in Baltimore. He reported his oldest son Tom is now on the faculty of Pennsylvania after getting his Ph.D. at Yale. All three of their sons graduated from M.I.T.: Tom in '68, Bob in '71, he's now a rock musician, and Peter in '72. Peter is a mechanical engineer with Machinery for Freezing in Billerica. We (Doreen and I) also saw Frances and **Dexter Clough** at the Pops and had a chance for a nice chat after the concert. The next day we saw Jane and **Peter Grant** and **Randy Antonsen** at the alumni luncheon. **Leo Beckwith** and Betty were in China at the time on a three week trip which I hope to tell you about later.

After two unsuccessful attempts Barbara and **Dick Shaw** and Doreen and I are postponing a golf get-together until the heat and humidity of July and August have hopefully changed into the cooler breezes of September. In the meantime the Class golf tournament is in the middle of the second round. If you lose here, you wait until next year. . . . I received a nice letter from **Lee Abramowitz**, Bill's widow, which I would like to share with you. "Enclosed is the program of the most recent William Abramowitz Memorial Concert." (This was the Borodin Quartet concert held May 1, 1979, by the Department of Humanities at M.I.T.). "Already Professor Douglas has notified me that on February 26, 1980, there will be an opera performance which will mark 20 years since Bill gave this gift to M.I.T. to the School of Humanities. This has been a very exciting experience to our whole family. I hope you can share this with us on February 26. Last May, **Sidney Baum** from Los Angeles was driving from New York when he heard the announcement of the concert on the radio. He got out of his car in New Jersey and called M.I.T. It was such a pleasant surprise to have him present at the concert, which was terrific., M.I.T. has handled Bill's gift in a way that could be an inspiration for others to do likewise. Best wishes to all, I love living in Washington, D.C. It's a great place."

The following notes came through the Alumni Fund offices: From the Buffalo, N.Y., area **Roger S. Brookman** writes: "Retired. Fully recovered from heart by-pass operation 2 years ago (Bless you). Traveled widely. Doing consulting for design and application of industrial dust collection equipment. Trying to learn to play a little — working on golf and tennis. Raised and educated 5 sons. They are all productive young men. We have 14 grandchildren."

From Louisville, Ky., **George C. Morrissette** writes, "Expect to retire from G.E. early in 1979, but will remain in Louisville doing consulting work in energy and environmental engineering."

James W. Libby writes from Wilmington, Delaware: "I may have already reported to you that I retired from DuPont after almost 40 years on Dec. 31, 1977. Helen and I spent six weeks in the Caribbean, one of them with **Jim Parker** and Mary, my sister, and then settled down into the pleasant routine that many of our classmates are becoming familiar with. I have spent too much time sailing to have improved my golf game enough to warrant entering the Class Tournament."

Stanley Lane writes, "Retired as manager of Asarco, Inc., East Helena, Montana on July 1, 1978 after 43 years. Will reside at Helena and catch up on my fishing, golf and traveling."

Gustav Maass writes from Minnesota, "My wife Patricia died of cancer last year. My son Major Brian Maass has completed his assignment in Germany and is now at the Army Command and General Staff School at Fort Leavenworth, Kan."

Herbert G. Anderton, Jr. advises: "Retired as a Vice-President of Liberty Mutual Insurance Co. on April 1, 1979, after 45 years and 5 months service." (I think that may set a record in our class for longevity with one company.)

Thomas Blair reports, "After being retired for eight years I ran for an unexpired term on the boro council and won. Now I have to run for a full term." Presumably, Tom refers to his home town, Eatontown, N.J.

Allen E. Beckwith wrote to me from B.U.: "I guess I finally have something to write home about. Enclosed is a copy of a squib in the local newspaper. I have just completed 33 years at B.U. and although I have reached emeritus status, I will continue to teach a reduced load. With best wishes to you and my classmates." The news article reports, "Allen E. Beckwith of Brookline, a marketing professor at B.U.'s School of Management, was awarded an honorary Doctor of Humane Letters degree by the University at a convocation on May 20. In honor of his reaching emeritus status this May, Beckwith's past students have chosen to honor him with an undergraduate scholarship fund that will carry his name." Congratulations! And it's nice to hear from you.

Mark your calendars: save the dates of June 5-8, 1980, for our 45th. Tech night at the Pops is Thursday, June 5 and Alumni, or Technology Day is June 6. We want to see you there and at the Wianno Club in Osterville at the Cape on June 6 thru 8. . . . Now to some more notes through the Alumni Fund Office: From **Dwight P. Merrill**, "My graduate work with Professor Harrison was a great start for my subsequent 32 years with Polaroid. Professor Hardy and Philip Morse were valued faculty. Fellows Shockley and **Dave Langmuir** are fondly recalled." . . . **Robert W. Spinney** writes: "Have been elected vice president of an electric cooperative board of directors, and chairman of finance, audit and long range planning committees of a generation and transmission electric coop. Recently inducted into Knights York

Cross of Honor in the Masonic orders, having served as presiding officer of all four York Rite Bodies."

Franklin A. Yates writes: "I was retired in January, 1978, from the Singer Co. at Elizabeth, N.J., after 40 years of service. Am now trying to catch up at home with some of the things that I never did get done." . . . From **Clyde K. Smith** comes: "Retired from Bechtel Corp. two years ago after 34 years with the refinery and chemical division. I am now doing volunteer work with the California Academy of Science in San Francisco Golden Gate Park." . . . **Dick Shaw** says, "We had a chance to ski for two weeks in Switzerland again this past winter. Now we are looking forward to the golf and outdoor tennis." . . . **Joe Simendinger** reports "Retired from Sikorsky Aircraft November 1, 1978, U.T.C. Industrial Engineering Department.

Elmer J. Roth, formerly of Warner, N.H., was installed this past spring as executive vice president of Nasson College in Springvale, Maine. Formerly he was chief financial officer for New England College and before that I think I remember him being with Stop & Stop. He will be in charge of all college matters excluding academic affairs and the library. He will be living on campus.

I am sorry to have to report the deaths of three more of our classmates: **Herbert Small** who died over a year ago in April, 1978, in Tucson and whom I remember in our Course VI classes; **Frank G. Marble** who died April 25, 1979, in Concord, Mass.; and **William F. Schult**, formerly of Winthrop, Mass., who died June 14 in San Diego. — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, MA 02160

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On Technology Day I say Kitty and **Herb Borden** and **John Zietlow**. The list of those planning to attend included **Herb Metten** although I didn't see him. The faithful were few!

A note from Louise Christenson tells sadly of the death of **Henry Christenson** on January 27 after a 14-month battle with cancer. Louise reports that he was able to be active professionally up until the last month. He was a numismatist and was recognized world wide as an authority on Spanish-American coins. I have written to her; for any of you who might wish to do so, the address is 19 Lawrence Rd., Madison, N.J. 07940.

The Boston *Globe* on Tuesday, July 10, reported the death on July 8 of one of our two class Nobel prize recipients: **Robert Burns Woodward**. Bob started a year behind our class, graduated with us and received his Ph.D. in organic chemistry the following year. That fall he started at Harvard as a research assistant and he was at Harvard ever since. At the time of his death he was Donner Professor of Science. In addition to the Nobel medal he received more than thirty other awards and some 25 honorary degrees. When I last saw Bob, some time ago, he was taking off for Switzerland to the Woodward Research Laboratory in Basel. He said that he had no plans to retire because he was doing what he liked to do best. The world has lost one of its premier synthetic organic chemists.

Now, for some happy news: Class President **Tony Hittl** was married in July to Dorothy Cobb (the widow of an old friend) of Laguna Hills, Calif. The couple will be back in Pleasantville, N.Y., as you read this, and expect to return to California in January. I am sure we all wish them a happy life together.

If you read this in time and can make it, do plan to travel to West Hartland on Saturday, October 27. You will be very welcome. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

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The response to the bigger birthday card has been great. One comment was "I assume the larger card is for more news or is it to be more visible for our advanced years," another wrote "thanks for this reminder card," another "what would we do without you fellows." These comments should give encouragement to write to those of our class who have not written for years and years. Try the new card; it is easy to fill out. . . . **Lewis (Pete) Reitz, Jr.** is associated as engineer manager of Gray Engineering Labs, Inc., which is becoming first in videotape editing equipment. Pete lives at 700 Mexico Pl., Palos Verdes Est., Calif. 90274. He belongs to the Society for the Preservation of Variety Artists and is currently interested in promoting the return of the Big Bands. In regards to retirement he states that he is "too old for a job and too poor to retire." He has one son who is currently in Nigeria as a soldier of fortune. Pete ends his card by saying he is looking forward to the 45th reunion.

Dick Young is vice president at Arthur D. Little, Inc., and lives at 85 Grove St., Lincoln 309, Wellesley, Mass. 02181. Dick has published, *Joint Ventures — Planning and Action* (a book written for and published by the Financial Executive Research Foundation). As to retirement, Dick is studying for location and it looks like Newport, R.I., as of now. Dick and his wife Marg have three children. His son Dick is married and has two children; Steve is also married and has two children; and his daughter, Pam, is a career person. Dick mentions that at our 40th reunion we voted to publish a photo book for the 45th reunion. I looked up the minutes of the class meeting — **Dick Young** was elected our 45th reunion chairman, and **Nancy Klock** is chairperson of the 45th reunion book. **Nancy**'s address is 63 Henry St., Manchester, Conn. 06040. This issue will alert all of our class to have a recent photo ready when you are contacted by the committee on the reunion book. . . . **Phil Dreissigacker** lives at 814 Hollyhock Ln., Orange, Conn. He is vice president of technology of the Farrell Co., Ansonia, Conn. Phil expects to retire in 1980. He has two boys in business together in northern Vermont — Product Design Engineering, and they are in the same town (Morrisville) as **Gray Jensvold**, and **Bob Weppler**'s son. Phil is general chairman of the United Way for Naugatuck Valley. Phil's hobbies are woodworking, gardening and skiing. . . . **Ed Hobson**'s address is P.O. Box 100888, Nashville, Tenn. 37210. He is president of Alladin Synergetics, Inc., of Nashville. Ed is a member of the Plastic Pioneers, Society of Plastic Industry and Beefeaters. He has traveled in Europe, Australia, New Zealand and Ireland. As to retirement Hobby reminds us that he has five in college and two in prep schools. His wife is a Doctor of Psychiatry. He is also vice president of Alladin Industries, vice president and director of Aerodyne Development Corp., chairman and president of Temp-Rite International Inc., vice president and director of Acton Corp., and executive committee member of Strategic Planning Institute.

Phil Peters, senior vice president of group operations for the John Hancock Mutual Life Insurance Co., has been named executive vice president group operations. . . . **John G. Booton** retired from Philips Industries in 1978 and is now doing consulting work for Masonite Corp., Fabricating Division in Watsontown, Penn.

I have been informed that **Ezriel Post (Postofsky)** passed on in April 1979. — **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medord, MA 02155; **Lester M. Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148

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Dr. **Robert H. Cotton**, chief food scientist at I.T.T., received the 1979 Babcock-Hart Award for his contribution to food technology. Bob's career has been involved with improving health via nutrition. He developed a process for vacuum evaporation of orange juice and has directed research at major sugar and baking companies. He was a panel member on the White House Conference on food, nutrition, and health.

Gus Hunicke and Prilla took time from sailing to send a handsome brochure outlining products made at their Precision Timing Co. A look through this literature shows Gus's and Prilla's timers are for the waterfront — perhaps explaining how they provided a good time to all guests who sailed with them at the Reunion. — **Hal Seykota**, Secretary, 1421 Calle Altura, La Jolla, CA 92037

A Challenge Grant for the Class of 1942 Professorship

With about two-and-a-half years to go, the Class of 1942 already has $700,000 toward its goal of a $1-million 40th reunion gift to fund a distinguished senior professorship. The Phoebe W. Haas B Trust, with strong support from John C. Haas, S.M. '42, has made a $500,000 challenge grant: every dollar pledged by members of the class will be matched on a one-for-one basis. Now the goal has been moved up: the class wants to reach the $1-million mark before the end of the Leadership Campaign next April.

The fund-raising effort is being led by Reunion Gift Chairman Floyd A. Lyon, with help from a Reunion Fund Committee that includes Class President George J. Schwartz, who conceived the idea of the professorship as an appropriate reunion gift. The class intends its professorship to "recognize and encourage innovative and imaginative teaching by outstanding faculty members whose careers reflect the traditional close coupling of teaching and research at M.I.T." For the first five years, it will be held by a faculty member affiliated with the School of Chemical Engineering Practice in the Department of Chemical Engineering; thereafter it will be available to faculty throughout the Institute.

Robert Cotton

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Pops of course. Thursday, June 5, is Tech Night at Pops next year. Many who went to Pops concerts in undergraduate years will miss the familiar Fiedler on the podium.

Tech Day. The following day, Friday, June 6, 1980, will see our 40th Reunion activities begin.

October Fest. This month in Hershey, Penn., the weekend Oct. 12-14, **Norm Klivans** is holding the mini-reunion for the Class of 1940. You should have received travel and location details in a direct mailing this past summer; you can contact Norm at 14731 County Line Rd., Chagrin Falls, Ohio 44022, (216) 247-5440.

Gold Medal. **I.M. Pei** received the American Institute of Architects Gold Medal in June. He is the 41st architect to receive the award, given this year in Kansas City, Mo. Pei is now designing a hotel for the Chinese government in Peking. — **Frank A. Yett**, Secretary, Box 488, Seaview, WN 98644

An honorary LI.D. for Bryan F. Smith, '42. After 25 years with Texas Instruments, Inc., where he is now a general director, Mr. Smith in 1976 became for two years chancellor of the University of Dallas. Now that university has expressed its appreciation: in May, the Most Reverend Thomas Tschoepe (right), grand chancellor of the university, presented the honorary doctor of laws honoris causa for "distinguished contribution . . . to the business community of the region and the nation . . . (and for) eminently successful contributions to the university." (Photo: Gloria Montgomery from the University of Dallas)

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I received the following letter which I first thought was another one of those fakies from Yale, but apparently is not:

"Dear Dick: My husband (your classmate) has been acting strangely lately. He has taken out all of your class reunion mementos and is displaying them prominently all over the place. The tenth reunion ceramic ash tray adorns my original LaVine brass coffee table, he wears the undersized 20th reunion crew hat to work, had six of the 25th reunion ash trays made into an hors d'oeuvres tray, drinks his milk only from the 15th reunion beer mug, wears the 35th reunion hat for golf, and insists on mixing martinis with that reunion's cocktail gift set. He got a vanity license plate with 'MIT-43' for his Bronco, and one with plain 'MIT' for my cardinal red and gray Eldorado Biarritz convertible. He plays the number 1943 in the daily lottery every day and has renamed our old dog, 'Tech.' — *A Worried Wife.*"

Dear Worried Wife: What your husband (my classmate) is doing is not at all strange or unusual, nor is it unwholesome. Almost all of our classmates do it, to a greater or lesser extent, out of an uncontrollable urge to express their love for our class and for their alma mater. Some have overcome this urge, however, and, in a "guilt complex" reaction, send money to the Alumni Fund instead or make huge donations to the class gift program which **Stan Proctor** is running. I do not recommend that you see a psychiatrist, but I believe you should sell your Eldorado convertible to me at its wholesale value and buy a moped, which needs no license plate. — *Dick.*

Richard R. Raven has been promoted from technical manager to vice president of engineering at Bath Iron Works, Maine. During his 33-year career there, he has been involved in design and construction of 134 naval and commercial vessels from yachts, frigates and fishing trawlers to containerships, contributing much toward the shipyard's successes in delivering high-quality ships on schedule and within prescribed costs. . . . **Al Emond** reminded us that he is still busy in his retirement in southern California, doing land planning development and real estate sales in between his work as a chemical coatings consultant. . . . **John H. Lutz** is retired and living on St. John, British Virgin Islands, in the winter and at his cabin on a lake in Bremen, Maine, in the summer. **George W. Potts** has also retired.

Frank J. Gardiner was killed last February in an auto accident in California. He had been technical director with Honeycomb Roll Systems, Inc., Saco, Maine, since 1975, and prior to that had been with Laser Credit Control (verifying credit card equipment) and was R.C.A.'s lunar module program manager. He held numerous patents for a wide variety of technical developments, including television tubes, radar devices, microwave equipment, and paper production instrumentation. He also was the author of numerous technical papers.

I hope that all of you have had a pleasant summer. I have been rather involved this year, because our one-and-one-half-year trial of the cases I'm working on will start in October. I did take a week off in May, however, to participate in the National Security Forum at the Air War College at Maxwell A.F.B., Alabama. — **Dick Feingold**, Secretary, 799 Prospect Ave., West Hartford, CT 06105

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We're hoping to see many of you in the next picture to be taken at the next major class event in Mexico in 1981. We have a nice Bermuda picture taken at the beach party during our 35th reunion. **Arturo Morales**, with the help of **Joe Aguila** and **Larry Lamadrid**, promises us special events, trips, etc., at the usual M.I.T. Fiesta in Mexico. We'll keep you informed. Already we've started a special account for this not-to-be-missed trip.

From **Arthur F. Peterson, Jr.**, we have a letter that tells of a planned early retirement and the dedication to a new project with nationwide scope. Ronnie and Art plan to devote most of their time to Compassionate Friends, a self-help group for parents who have lost children. Their participation goes back to 1970 when their son Tony, then 17, was killed in an automobile accident. They feel that those who have survived this terrible shock and who have learned to live with the pain are best able to help others. They ask that any of our classmates who have lost children or know of a bereaved parent kindly write to them at Star Lake, N.Y. 13690, to find the nearest chapter of Compassionate Friends — no fund raising or bother — just "time and love and the ability to listen."

Flap Facts: **Edward P. Radford** writes of "exciting and difficult times as health effects of low-level ionizing radiation became big news after Three Mile Island." He has also been involved in the intense activity within the National Academy of Sciences Committee. "Never a dull moment," he says. You may recall his role as professor in the department of environmental medicine at John Hopkins. . . . **A. A. (Bud) West**, still in Newport News, Va. (so close to the Tides Inn and we missed him for our 34th.) He and Elizabeth celebrated their 35th wedding anniversary in April. (That makes at least three couples celebrating their 35th anniversaries with the Class!) Bud is in his second year as president of the Peninsula Chamber of Commerce. The Wests are proud grandparents of seven granddaughters. He also sends us news of another "Bud", **F. E. (Bud) Brown** whom he met in El Paso, Texas, recently. . . . **Trigg Noyes** sent us best wishes for the Bermuda trip. He's planning a full family sailboat reunion in the Chesapeake Bay in August.

September should find Newton finally returning to work following a mid-July heart attack. Hope you enjoyed the autumnal equinox and its attendant changes. — **Melissa** and **Newton Teixeira**, Co-Secretaries, 92 Webster Park, West Newton, MA 02165

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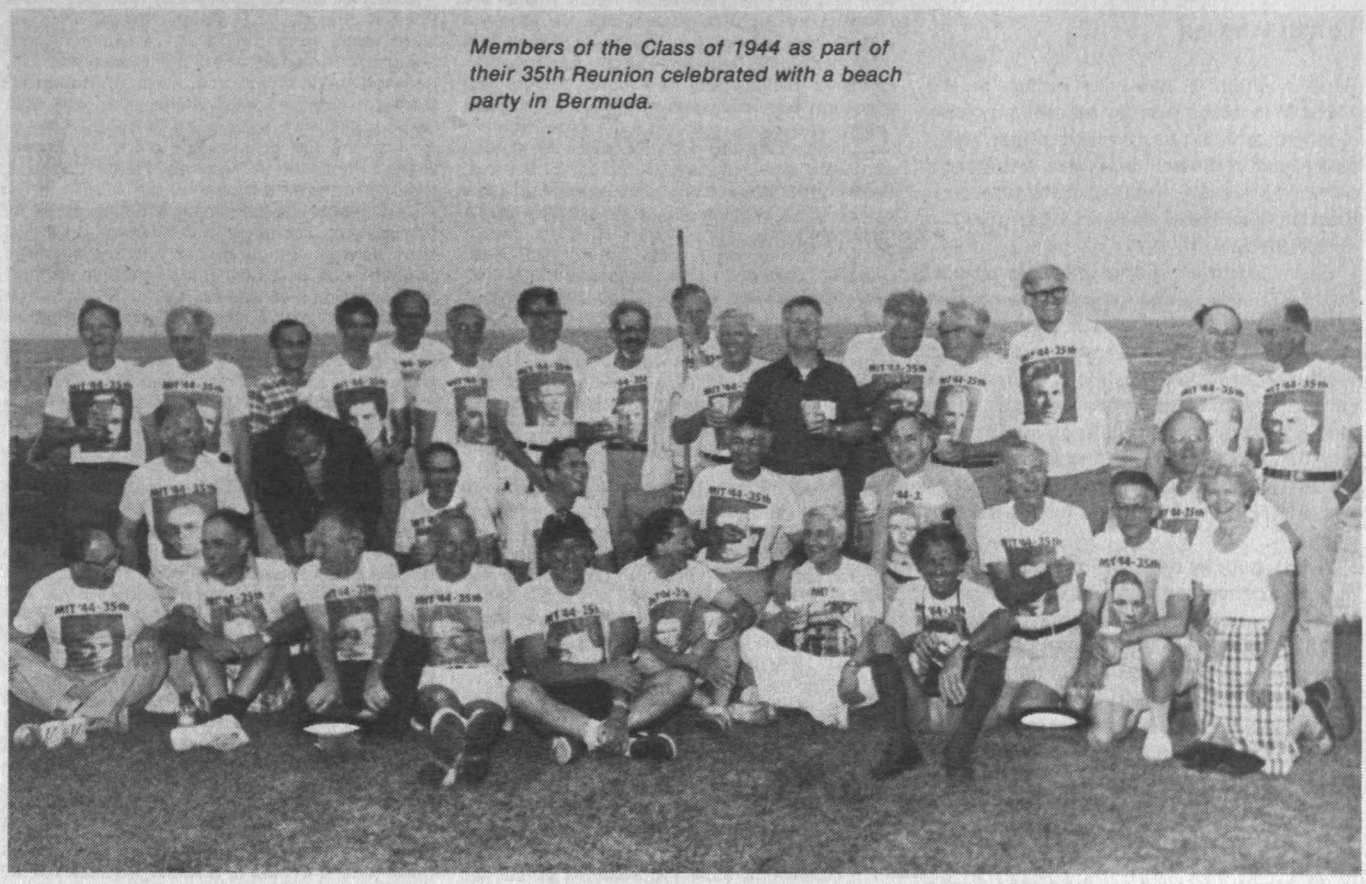
We are saddened to report the death of **Curtis H. Elliott** of Baltimore, Md., on January 24; unfortu-



Members of the Class of 1944 as part of their 35th Reunion celebrated with a beach party in Bermuda.

nately, we have no details.

Jacques B. Skinner has recently completed 15 years of service with Aerosonic Corp., an aircraft instrument manufacturer in Clearwater, Fla. . . . **Jack Brannan** continues as a transportation systems consultant specializing in all aspects of railroads and rail mass transit. . . . In May **Matt Lebenbaum**, vice president of Cutler Hammer's A.I.L. Division received the Outstanding Engineering Manager award from the Long Island section of I.E.E.E.

The 35th Reunion of our Class will be held at the M.I.T. campus and the Wechmere Harbor Club — Old Snow Inn — in Harwich Port, Mass., on June 5-8, 1980. Please set these dates aside as you await details from Reunion Chairman, **Bill Shuman**. — **Clinton H. Springer**, P.O. Box 288, New Castle, NH 03854

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General **Hillman Dickinson** has been promoted from Major General to Lieutenant General effective July 20, 1979. Hillman becomes director of organization for the Joint Chiefs of Staff and will be stationed at 158 Jackson Ave., Fort Myer, Va. 22111.

We have received a letter from Ellin E. Jackson reporting the death of her husband **Hugh R. Jackson** on April 19, 1979. Hugh graduated from M.I.T. with his Navy V-12 unit in 1946. He remained actively involved in the Naval Reserve in the submarine division while working in the research division of the Atlantic Refining Co. Atlantic merged with Richfield Oil in 1966 and Hugh transferred to the combined research department in Anaheim, Calif., as the director of fuels and lubes research. Later, when the company merged with Sinclair Refining, Hugh was transferred to the research facility at Harvey, Ill. After less than a year, Hugh left Arco in 1970 to join Union Oil of California where he remained as refining research manager. Hugh died at St. Jude Hospital at age 54 after a lengthy illness. He is survived by his wife and daughters, Mary Gill Wood and Rachael Jackson II. — **Russell K. Dostal**, 18837 Palm Circle, Fairview Park, OH 44126

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This month's class notes are coming to you from the newsroom of the *Latin America Daily Post*, Sao Paulo, Brazil, typed on Telex tailings. Naturally they will be mostly about Brazil, since I have been here several days now.

But first the class. News of Technology Day attendees will come next month; my notes are not here.

Jordan Baruch, assistant secretary for science and technology in the Commerce Department, was the principal speaker and also participated on the engineering panel in the afternoon. He spoke optimistically of federal policy and innovation (reported in the *Review* last month) and also noted to me that this year is one of our more important reunion years, 32 being 2^5. Sadly, however, this makes our next reunion (2^6) 32 years hence. Jordan is widely quoted; an article on increased industrial research spending in the July 2 issue of *Business Week* carried several of his comments.

Vince McKusick, chief justice of the Maine Supreme Court and former chairman of the Board of Editors of the *American Bar Association Journal*, was awarded the honorary doctor of laws degree at Bowdoin College commencement in May. Bowdoin President Enteman said Vince's "early service as law clerk to both Justices Learned Hand and Felix Frankfurter nurtured the brilliance that was to mark his career. . . " Didn't mention us at all.

And now a bit about Brazil because **Ginny Grammer** is there (here?). The day I arrived, the price of diesel fuel went up 50 per cent, with another increase expected in August. As in the U.S., there has been violence in the diesel lines,

Vince McKusick

and gasoline stations are closing on weekends. Petroleum substitutes are being researched. Palm oil and castor oil are being consider as diesel fuel replacements, eucalyptus leaves (3 crops a year!) for methanol for industrial plants, and alcohol from sugar cane for gasoline. In Sao Paulo gasoline already contains 20 per cent alcohol, the most that can be used without adjusting the carburetor. Painted with the legend "Movido A Alcool" Government cars are running on pure alcohol. Brasil is the world leader in alcohol technology. In several past eras alcohol has been used here in cars: in the 1920s in the northeast to replace scarce gasoline; in the 1930s to use excess sugar cane; and now, as in the States, to reduce dependence on imports. But cars are still plentiful in Sao Paulo, from LTDs to VW bugs (more of the latter, but many medium-sized Brazilian-made Fords, Chevrolets, and Dodges). Both of the other women in my daughter Margaret's apartment own cars (one is considering a motorcycle also to save gas). Traffic is still intense. Crossing the street is still hazardous. Pollution is still high.

Margaret works for the *Daily Post* as a feature writer, and represents ABC radio in Brazil. In addition, she writes for others, including some Brazilian publications. She has, besides her newsroom desk, part of a suite of offices shared with

1.0 TMI = 10 mR

People within a five-mile radius of the Three Mile Island nuclear reactor may have received as much as 10 milliroentgen (mR.) as a result of the accident there last March. None was injured — either at the time or in the definite future, as far as can now be determined.

Eli I. Goodman, '50, of the International Atomic Energy Agency, thinks this episode gives us a chance to adopt a new, much more meaningful unit of radiation: the TMI — the dose (clearly without hazard) received by many within five miles of Three Mile Island. This one puts radiation dosage into "everyday, human terms," writes Mr. Goodman in *Nuclear News* (June, 1979); he thinks mR. is "too scientific for the general public."

"After people become familiar in their ordinary conversations with TMIs received by family and friends in their normal routine (perhaps 1.5 TMI in a dental x-ray, 21 TMIs in an x-ray examination of the gastrointestinal tract)," writes Mr. Goodman, "they would see the exposure obtained by the citizenry in the vicinity of Three Mile Island on a realistic, sound basis.

"After all, when one receives about 0.8 TMI during a vacation round-trip to Europe and perhaps an additional 1 TMI climbing in the Alps for a few days, the public can be more matter-of-fact and less emotional about the recent exposure near Harrisburg."

several other foreign correspondents who represent B.B.C., *The Economist*, Reuters, and the *Times* (London). I could embrace her life-style with no trouble at all. She lives in an elegant little three-bedroom, bath-and-an-half apartment in Pinheiros district with two other professional women, Vera, who speaks some English, and Lucia, who does not. (It is strange to hear Margaret's voice and not understand the words.) Both Vera and Lucia are psychology professors, Vera at the University of Sao Paulo and Lucia at a private college outside of Sao Paulo. They have a maid, Maricota, who comes in five full days a week to clean, do laundry, cook, iron, wash dishes. . . all things I could cheerfully forgo.

When I moved to Cambridge, I discovered that some houses have no central heat. Here houses have no heat. It is winter, and Sao Paulo is warm in the daytime but cool these evenings. A sweater or jacket is essential. The altitude (750 to 825 meters) produces a temperate climate, but the advertised low (13.4°C.) was exceeded recently when Sao Paulo had frost. It is warming, but slowly.

Sao Paulo city is a charming mixture of high-rise, both old and new, and large and small Portuguese-villa-style buildings, beautiful pastel houses with red clay tile roofs, sometimes with garden walls and ornamental iron on gates and windows. Few areas have large concentrations of high buildings without low buildings or parks between. From Margaret's window, for instance, you can see between other buildings to the university, four miles away.

Brazilian tile is used generously both inside and out, and the sidewalks are mostly black and white mosaic, usually in the pattern that approximates the shape of the state of Sao Paulo. Some common things that make sense are flexible water connections under sinks and door handles rather than knobs. On the other hand, the train to Brasilia takes longer than the bus. . .

To date we have been to a Samba school, the Sunday Hippie Fair in the park, on buses where they take the fare at a turnstile in the middle, and to a restaurant where the bill for dinner for three came to CR$80 (U.S. $3). (The next day, however, we paid CR$94 each for lunch.)

The day I arrived, Margaret's British journalist friend Brian arrived from Rio to discuss the possibility of his joining a TV station's expedition to the site of what may turn out to be pyramids in the middle of the Amazonian jungle. So you see life is busy here and certainly no simpler than in Boston. Me-escreva assim que puder. Tchau. — **Ginny Grammer**, 62 Sullivan St., Charlestown, MA 02129, U.S.A.

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30th Reunion notes will be brief because your new Secretary hasn't gotten all the names yet from the reunion chairman. My wife Virginia tells me I had a good time — both in Cambridge and Bermuda. Getting back to Tech is always fun and worthwhile — going to Bermuda with friends/classmates was marvelous. We did elect a new regime for the class: **Harry Lambe** is president, **Frank Hulswit** (who with his wife, Sonya, organized our 30th Reunion wo well) becomes vice president; **Jim Christopher** is treasurer, and **Paul Weamer** is secretary. Now you know who to contact for 50-yard-line seats at Tech football games, or for the procedures on large gifts to the Class of 1949 Visiting Professorship. We'll try to include the names of those attending the Reunion in forthcoming class notes. Suffice it to say that MacGregor Hall was nice, but the Inverurie was so much better.

Warren C. Fisher is teaching a process design course to evening students at Drexel University in addition to his full time duties as Project Manager at F.M.C. . . . Aileen and **Sid Howell** were unable to make our 30th Reunion because they were in Washington. Sid is group vice president of the Dana Corp. in Toledo. . . . **Robert O. Bigelow** has been named a vice president of New England Power Co. . . . **William A. MacLeod** has been appointed director of physical plant at Lasell Junior College in Newton, Mass.

Denny C. Kalette is business manager of the Pomfret School. . . . **J. Ralph Huggett** was on home leave from his Tehran assignment with Dynamics Research when the Shah went. So, Ralph stayed in Wilmington, Mass. . . . **Robert W. Decker** is now scientist-in-charge of the U.S. Geological Survey's Hawaiian Volcano Observatory on the rim of Kilauea's crater. . . . **Angelo Arena**, President of Marshall Field, is also a Director of Harris Bancorp.

Jack Baker is technical recruiting head of Management Recruiters of Ann Arbor. Jack and Mary were with us during our 30th in Cambridge and Bermuda. Jack also coordinated the summer jobs program, a service the M.I.T. Club of Detroit provides for Tech's Michigan students. . . . **Robert C. Peterson**, after 17 years in Iran, has come home to a new position with Phillips Petroleum in Bartlesville, Okla. . . . **Fred Reusswig** is in Muscatine, Iowa with Stanley Consultants, as head of the corporate development and services division.

"The New Astronomy," a three-part series published in the *Christian Science Monitor*, gave **Robert C. Cowen** a 1979 Science Writing Award from the American Institute of Physics United States Steel Foundation. . . . "Cars That Don't Protect You In A Crash" was published in the *Business and Society Review* and represents the continuing efforts of **William Haddon** in his lifelong campaign for Highway Safety.

We also sorrowfully report the loss of four of our classmates: **George D. Latimer**, **Richard H. French**, **Josiah Macy**, and **Edward T. Miller**.

I want to thank **Fletcher Eaton** and **Frank Hulswit** for making my new job as Class Secretary so hard — they are a tough act to follow. I followed the words of wisdom and news they have provided us for so many years in the *Technology Review*, and now I must provide them. Help me be as good as they — send news of you, yours, and other classmates so I can share them with all of us Forty-Niners. — **Paul E. Weamer**, Secretary, 5130 Regent St., Madison, WI 53705, (608) 233-3383

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That world trotter, **Dana Ferguson**, has sent a postcard from the Raffles Hotel in Singapore complete with a recipe for the famous Raffles Hotel Singapore Gin Sling. Dana is in Singapore on his way to Indonesia and Borneo. . . . **John S. Rydz** writes that he is now director of the corporate office of innovation for the Singer Co. . . . The new supervisor in the catalysis branch of the Pittsburgh Energy Technology Center, Department of Energy, is **Leon Polinski**. Leon is working on the economic conversion of coal to oils and gasoline. His son is now in high school and his daughter is a sophomore at the University of Pittsburgh.

David W. Ulrich notes that he left Creole Petroleum Corp. when it was nationalized by Venezuela and joined MacMillan Ring-free Oil Co., a small independent and a big change after 20 or more years with Exxon. David is now chief engineer for two refineries, one in Arkansas and the other in Southern California. He works from the corporate headquarters in New York City and travels periodically to the refineries. . . . **Bradley T. Sack** is in private architectural practice in Boston in his eighth year as consulting architect to the public facilities department of the city of Boston. He writes that it is a combination of "politics, architecture, construction and foolishness that I love and hate at the same time." Bradley is a single swinger after 22 years of marriage, traveling a lot trying to put it all together. He notes that it looks like he'll need another 50 years. Brad encourages all of you out there to write.

Battelle Columbus Laboratories have honored **Edward S. Lipinsky** for a patent he received in 1978. The patent is for developing a method to make alternatives to medicinal capsules. With this sytem, the drug is deposited on edible polymer films, inspected by nondestructive methods, and sealed into unit dose forms that have controlled release properties. Ed is now a resident of Colum-

Electric Rates Going Down as Technology Comes Up in the 1980s

For more than six decades the price of electric energy in the U.S. went down while the price of nearly everything else went up. Then came inflation, environmental controls, and the "energy crisis," and for the first time in history Americans had to accept electric bills on which the real price of energy was going up.

Now the picture is about to change again, predicts Professor Herbert H. Woodson, '51, director of the Center for Energy Studies at the University of Texas.

It was constant infusions of new technology which kept electricity prices on the downslope throughout the whole history of the utility industry until the 1960s, Professor Woodson told a University of Texas audience last year as he received the 1978 Joe J. King Professional Engineering Achievement Award from the University. Now, as utilities switch from oil to coal or nuclear fuel and as they adopt significant new technology which is nearly ready for commercial use, the trend of the real price of electric energy will once more be down. By the 1980s "the electric bill will once again be a decreasing fraction of the family budget," Professor Woodson predicted.

Among the technological improvements which will increase efficiency and decrease costs in the next decade, according to Professor Woodson:

— "Fluidized-bed" combustion of coal — a system where powdered coal is brought into the furnace suspended on an air stream while limestone (for sulfur removal) is fed separately at the same time. That development alone, said Professor Woodson, "appears to be capable of reducing the capital cost of a coal-fired boiler by a substantial amount while eliminating the need for equipment to remove (pollutants) from the stack gas."

— The substitution of superconducting materials for conventional ones — mostly copper and steel — in electric generators. Professor Woodson foresees "substantial reductions in cost and increases in efficiency" as a result.

— Cost reductions through more efficient operation of light-water nuclear reactors in current use in the U.S. In this case, Professor Woodson seems to be anticipating the "learning curve" improvements which come with familiarity wirth a new technology.

To assure these and other developments to minimize the cost of energy in the future, Professor Woodson urged increases in basic research and development. "To provide the greatest opportunity for our bright young engineers and scientists to produce technological advances," declared Professor Woodson, "we need to continue a vigorous research and development program, not being afraid to spend some of our affluence on far-out ideas.

"It is my opinion that into the indefinite future most of the U.S. population will continue to want, expect, and enjoy the comforts and conveniences afforded by high per capita energy consumption in a high-technology, productive, and affluent society."

Morton Grosser Conducts a Tour of Rudolf Diesel and His Engine

Rudolf Christian Karl Diesel was born in Paris of German parents. At the age of 20 he went with this parents to London, and ten years after that he had completed an international schooling in mechanics and was installed as an apprentice in a Swiss machine shop. He had proved himself a brilliant student, and now he advanced rapidly into engineering responsibilities for the Sulzer Machinenfabrik.

It was an exciting age for mechanical engineers. Steam engines were beginning to move trains, and internal engines were being mounted on vehicles soon to be called automobiles. Carnot had postulated his three conditions for engine efficiency:

— The temperature in the cylinder at the beginning of the stroke should be as high as possible.

— By the end of the stroke, the gas in the cylinder should be cooled as much as possible.

— The cooling should be spontaneous, with minimal heat lost to the cylinder walls.

And Diesel had observed the abysmally low efficiency of most of the engines then being built (never more than 10 per cent) and their proclivities to explosive failures.

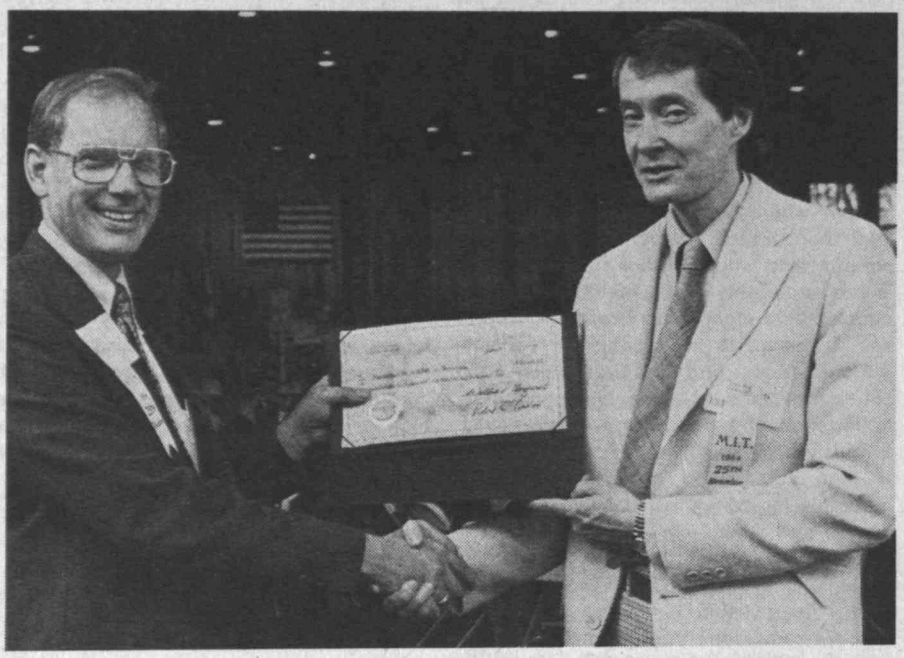
Rudolf Diesel was assigned to supervise a plant manufacturing refrigeration engines near Paris, and for a number of years his innovative talents were absorbed by his concept of an ammonia engine. Then came what **Morton Grosser**, '53 calls "a crucial conceptual leap." Diesel decided that "what really mattered in a heat engine were high temperature and high pressure," writes Mr. Grosser in his newest book, *Diesel: The Man and the Engine* (New York: Atheneum, 1978, $8.95). "If you could raise those quantities to extreme levels before the power stroke, you could produce a very efficient engine with any working fluid — gas or vapor, or even ordinary air."

No entrepreneur ever finds his invention as simple to realize as to conceptualize, and Diesel was no exception. Only after four years of "small triumphs over many tedious disappointments" (including at least one explosion which proved the point but nearly decapitated the inventor) did Diesel's test engine run for as long as one minute — 88 revolutions on its own power.

Mr. Grosser's story has barely begun at this point: there are victories and disappointments, trucks, automobiles, bulldozers, racing cars, stationary engines, even airplanes in the cast of characters. At least one family of diesels is so large that elevators are provided to carry mechanics six stories from the bottom of the crankcase to the cylinder head.

"Everywhere that people need power, the use and manufacture of diesel engines is growing rapidly," writes Mr. Grosser. Indeed, you may one day be startled to drive up behind a car and see a new word on its trunk: "gasoline," he writes with his tongue in his cheek.

Mr. Grosser studied mechanical engineering at M.I.T. and then went on for a doctorate in the history of science at Stanford. He now divides his time between writing and consulting about engineering. He's written four books and many articles for (among others) *The Atlantic*, *Harper's*, and *The New Yorker*. — *J.M.*



That check says $338,119 from the Class of 1954 — its 25th reunion gift to M.I.T. The check was prepared to dramatize the gift when it was announced to President Jerome B. Wiesner at the Technology Day luncheon last June 8; it's displayed here by Robert A. Anslow, the class' reunion gift chairman, and Wallce P. Boquist, president. (Photo: Margo Woodruff)

bus, Ohio. . . . The General Tire and Rubber Co., chemical/plastics division, has announced that **Eugene D. Scalera** has been named president of the G.T.R. Foam Products Co., one of the operating units of General Tire and Rubber. Eugene was formerly a division vice president and will be based at General Tire's Marion, Ind., facilities. He joined General Tire in October, 1978, after being with the Joseph Schlitz Brewing Co. as vice president of operations and the Sinter Co. as president of the climate control division. Eugene and his wife, Mary, have a daughter and two sons. — **Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, MA 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, CA 94301

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Our 25th Reunion has come and gone and after so many years of preparation by so many classmates, it seemed over so quickly. Based on comments heard among the 146 alumni who attended, everyone seemed to have a very enjoyable time. Members of the class came from many distant points such as Hawaii and Central and South America. We stayed at McCormick Hall and this dormitory is certainly much different from what we experienced in the '50s. It is a relatively new dormitory built in the '60s with excellent facilities and pleasant surroundings.

During registration on Wednesday, June 6, and Thursday, June 7, **Dean Jacoby** was kind enough to provide a Polaroid camera and accessories so that each member of the class could be photographed — a big help in recognizing some of our old classmates who may have aged a little bit. On Thursday evening we all attended the Tech Night at the Pops and then proceeded to the famous Quincy Market area in Boston for a little dessert and coffee.

On Friday, June 8, most attendees wandered around the campus inspecting old classrooms and dormitories. Noon on Friday, the Technology Day Luncheon was held, at which time our Reunion Gift Chairman, **Bob Anslow**, presented to Dr. Wiesner our class gift — $337,618, representing gifts from 60 per cent of our class. This level of participation is a record for the 25th Reunion Class, exceeding 59 per cent by the Class of '53 last year. **Bob Anslow**, President **Wally Boquist**, Class Agent **Joe Blake**, and all the rest of the class officers and members of the Reunion Gift Committee worked very hard in achieving this goal, and our thanks go to them and all our classmates who made this possible. Bob and his committee were actually still making phone calls soliciting donations right up until noon on Friday, June 8.

A class photo was taken Friday afternoon which I am sure is available by contacting Reunion Chairman **Bob Warshawer**. The majority of our classmates look in remarkably good shape except for a slight lack of hair on top of some of us. On Friday evening we attended a reception at Dr. and Mrs. Wiesner's home and then adjourned to the Hyatt Regency Hotel for the Reunion Dinner/Dance. Our class Vintner, **Mickey Sama**, provided his own home-brewed wine for each table. Connoisseurs reported the wine to be of excellent quality, and the empty bottles disappeared fast as souvenirs.

On Saturday, June 9, the class took a boat ride to Georges Island in Boston Harbor, where we spent an interesting day enjoying a sumptuous clam bake and an inspection of Fort Warren. On Saturday evening an informal buffet and dance was held at the Stratton Student Center at which time the election of class officers took place. The following slate of officers was chosen: President — **Frederick (Larry) Holmes**; Regional V.P. East Coast — **Harvey Steinberg**, West Coast — **Bob Anslow**; Treasurer — **Bob Evans**; Secretaries — **Bill Combs**, **Jack Kiley**, **Lou Mahoney**, **Dom (Mickey) Sama**; Class Agent — **Frank Ahearn**; Class Estate Secretary — **George Schwenk**; Reunion Chairman — **Bob Warshawer**. **Bob Evans** presented the results of the class questionnaire which proved interesting — we will give you these results in the next issue. **Bob Warshawer**, as M.C. of this final affair, presented a number of unusual awards to members of the class but unfortunately no notes were kept on this event so we cannot give you much detail on this item unless Bob's memory assists us.

In conjunction with the reunion there was a separate program for the children and from all accounts this was a huge success. A reunion such as the 25th requires a lot of preparation and planning and thanks must go to **Bob Warshawer**, our Reunion Chairman, for putting everything together so well. He was ably assisted by a Reunion Committee consisting as follows: Publicity — **Dave Howes**, **Dean Jacoby**, **Lou Mahoney**, **George Schwenk**; Registration — **Bob Evans**; Program — **Joe Blake**, **Wally Boquist**, **Bob Evans**, **Harvey Steinberg**; Youth Program — Ruth and **Dave Whitehouse**; Class Vintner — **Mickey Sama**. We must also give credit to the able and hard working Joe Martori, Ann Perry, and others of the Alumni Staff for their assistance before and during the reunion.

We have some other news of fellow classmates we would like to share with you. **Milton L. Almquist** recently co-authored a paper entitled, "Switch System Maintenance — and More." Milton has worked for Bell Laboratories since 1959 in a succession of positions. He is currently head of the switch maintenance studies departments for Bell Laboratories in West Long Branch, N.J. . . . **William S. Zoino** was recently elected president of the Boston Society of Civil Engineers Section, A.S.C.E., at the 131st Annual Meeting of the Society held at the Parker House in Boston. Bill is a principal in the geotechnical engineering firm of Goldberg, Zoino, Dunnicliff, and Associates, Inc., in Newton Mass. Bill resides in Brockton, Mass., with his wife Ann and daughters, Julia, Kate, and Paula. . . . **Edwin G. Eigel**, presently academic vice president of St. Louis University in Missouri, has been named vice president for academic affairs at the University of Bridgeport, Conn., effective August 15, 1979. Ed was selected by a search committee from 250 nominations. I am sure most of you remember that Ed was our Class Secretary for a number of years back in the '50s, and we wish him well in his new endeavor.

Gordon Aitken was promoted to the position of director of engineering at the administrative headquarters of the International Salt Co. in Clarks Summet, Penn. Gordon will be responsible for developing the production division's strategic plan and directing the engineering activities of all phases of salt production, processing, packaging and handling. In this new position, Gordon will be residing in the Abington area with his wife Audrey and two daughters, Patience Ann and Audrey Hope. . . . **Anthony Turano, Jr.**, has been elected vice president for corporate planning of Commonwealth Oil Refining Co. Tony has worked at several other oil companies before recently joining Commonwealth. Tony stayed at M.I.T. after graduating and obtained his masters and doctoral degrees in chemical engineering. . . . **Robert H. Brown, Jr.**, has been elected president and chief operating officer of Belding Heminway Co., Inc. Bob, a native of Leominster, Mass., joined Belding Heminway in 1954 and has held a number of positions since that time. He resides with his wife and family in Greenwich, Conn.

You will note that we now have four class secretaries, since that is what was necessary to fill the shoes of **Dave Howes** who did such a great job for the last 18 years. We ask for your help so that we might maintain Dave's efforts. — **William Combs**, Secretary, 120 West Newton St., Boston, MA 02118; **John Kiley**, Secretary, 7 Kensington Rd. Woburn, MA 01801; **Louis Mahoney**, Secretary, 14 Danby Rd., Stoneham, MA 02180; Dr. **Dominic Sama**, Secretary, Chestnut Hill Rd., Groton, MA 01450

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We have apparently hit the summer doldrums as of this writing, with only a few pieces of hard news, much of which is on the sad side.

First, on a happy note, our congratulations to **Russell G. Meyerand, Jr.**, who in May received the Connecticut Patent Law Associations' 1979 Eli Whitney Award. Russ, whose achievements were recorded in this column last year, is director of research for United Technologies Corp. in East Hartford, Conn., and holds patents for 15 inventions ranging from magnetohydrodynamic generators to photoelectric production of hydrogen.

On a much sadder note, we must advise that Margaret Hughes Young, who graduated in 1956 in Course V and VIII, died of cancer in June. Mrs. Young had been one of America's premier woman mountaineers until her partial paralysis in a 1977 riding accident. Prior to that accident she had climbed in Yosemite National Park, Mexico, Latin America, Alaska, Nepal, and Afghanistan — one of her many achievements being a 1972 ascent of 24,500-foot Mt. Noshaq in Afghanistan which then tied the altitude record for American women mountaineers. Mrs. Young was also an accomplished aviatrix, owning a Cessna 180 which she flew to climbing expeditions throughout North America. She also was a licensed airplane mechanic, performing her own maintenance prior to her accident. In the two years prior to her death she had made many friends among the wheelchair-confined, and she had served the National Science Foundation on a panel evaluating grant proposals aimed at solving problems of the handicapped. **Dick Schwind** provided us with the sad news, recalling that he had climbed with Margaret at Mt. Katahdin, Maine, and Mt. Shasta, Calif., and had seen her several times since her paralyzing accident.

Though he died in 1976, we have only now learned of the death of **Richard C. Engelken**, Course XX.

Turning to gladder tidings, at the present writing some 147 replies have been received to the initial mailing about our 25th reunion. Of those, some 110 classmates have indicated they will probably — or definitely — attend the reunion. A majority has also expressed a preference for all reunion activities in Cambridge, a substantial minority preferring some activity at a North Shore resort. If you have not yet responded, please write to your reunion chairman, **Paul Attridge**, at 59 Powers St., Needham, Mass. 02192, to indicate whether you will be able to join us in June. The early numbers indicate that we should have a banner turnout. Incidentally, Paul is still involved in the insurance business, his agency having recently expanded by merger.

With further reference to the Reunion itself, June 5 will be Tech Night at the Pops, and Technology Day during which we will present our class gift will be Friday, June 6. Details as to additional activities on June 6, 7, and 8 will be spelled out in later mailings, the first of which should reach you at about your reading of these lines.

Last but not least, a few words about your Massachusetts co-secretary, **Allan C. Schell**, who, when asked for some current biographical information, reported only that he is "sinking deeper and deeper into the bureaucracy." Allan, are you speaking for yourself or for Eileen whom, we understand, was appointed this year as the Secretary for Consumer Affairs for Massachusetts and is the only member of the governor's cabinet who rides a bicycle (license "Air-Force One") from Winchester to Boston instead of using a limousine for commuting. Rumor further has it that the Schell's eldest daughter has recently graduated from Wellesley, and their youngest has now matriculated at that institution.

Please send more news so that we can save you further details. — Co-secretaries: **Marc S. Gross**, 341 South Bedford Dr., Beverly Hills, CA 90212, and **Allan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

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Henry McGrath reports that he has given a number of talks during the past year on the only commercial coal-to-gasoline plant in the world. Located in South Africa, the plant uses a process Henry patented many years ago. It will be interesting to see what develops in the future.

For details on the death of **Margaret Hughes Young**, see Class of 1955 notes. — **Warren Briggs**, Secretary, 33 Bancroft Rd., Wellesley Hills, MA 02181

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I've spent only 24 hours of the past two months in the country, but that was long enough to catch up on some good news. Congratulations to **Guy Carbone**, who was named Metropolitan District Commissioner in Massachusetts. . . . **Edward Roberts**, who teaches research and development management at the Sloan School, spoke on "The Roles of the Engineer in Corporate Innovation" during Engineers' Week last February in Boston.

Apostolos Kizilos writes that he is spending the summer by a beautiful Minnesota lake. His eldest son, Peter, was declared a National Merit Scholar and is planning to attend Yale. He and his wife of 21 years, Betty (class of '58, Course VIII), send greetings to friends everywhere. . . . **Richard Smallwood** left his job as manager of the Analysis Research Group for Xerox to become president of Applied Decision Analysis, Inc. He will continue as a consulting professor in the Department of Engineering-Economic Systems at Stanford. . . . Dr. **Stanley Cortell** has been appointed acting director of the medical service at St. Luke's Hospital Center in New York City. . . . **Bill Walsh** has been promoted to executive vice president of Mobil in Tokyo.

From **Boyd Givan**, word that after 13 years at Boeing in Seattle in various financial capacities he is now director of finance for the 707/727/737 Division. He and his wife Ann have three children: Caroline, 16; Bill, 14; Charlie, 11. . . . **William Schoendorf** is a member of the staff of Lincoln Laboratory and has published an article dealing with "Applications of Statistical Pattern Recognition to the Design and Discrimination of Ballistic Targets."

Nelson Disco is now manager of ocean engineering for the Ocean Systems Division of Sanders Associates, Inc. . . . **Paul Nicholson** writes that he's ". . . into nuclear safety and research and some lecturing at M.I.T., so am keeping busy responding to the Three-Mile-Island 'incident.' " He also is thinking about the 25th anniversary gift. Any suggestions? — **Fred L. Morefield**, Secretary, Aquetong Rd., Carversville, PA 18913

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Jerry L. Adams has been appointed associate professor of physics to the Roanoke College in Salem, Vir. . . . **Gregory N. Gabbard** recently received the John Masefield Award of the Poetry Society of America for 1978. Gabbard's winning entry "Dragon Raid" is based on an historical incident, a Viking raid against Rome in the year 860 A.D.

I would very much like a volunteer to take over the position of class secretary, as I've performed it now for 17 years. Please write — you might enjoy it. — **Gerald L. Katell**, Secretary, Seven Silverbit Ln., Rolling Hills Estates, CA 90274

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We have an unusual situation this month: Because of your good support of the Alumni Fund, there is an oversupply of news. So please don't be perturbed if your news isn't in this month's notes — I'm spacing things out over a few issues.

Family news: **Ted Cohn** reports the birth of his first child, a son, on March 25. Avery Simon Cohn was born less than three weeks after his mother, Barbara, passed her qualifying exam for a Ph.D. in epidemiology. . . . **J. F. McDonald** writes that after many years of bachelorhood he married Karen Marie Knapp of Troy, N.Y., in May. Karen is a nurse and is currently working for New York State. . . . Another wedding in May, this one at the M.I.T. chapel, saw **Steve Ditmeyer** take Martha Stark as a bride. She is the daughter of Dr. and Mrs. Charles Stark Draper.

Frank Verlot was recently appointed to the Los Altos, Calif., City Planning Commission. In his spare time Frank works on refurbishing his "do-it-yourself fixer-upper." . . . **Dan Greenwald** is presently assistant director of psychiatry at Muhlenberg Hospital in Plainfield, N.J. . . . **Gus Dreier** is a principal mechanical engineer with I.L., Inc., in Lexington, Mass. His work involves the development of medical instrumentation. Gus is married, has two children, and enjoys power boat and bicycle racing.

Dennis Wood is an engineering flight supervisor on the Flight Controls Technology staff of Boeing's Commercial Airplane Co. He enjoys the great Pacific Northwest with his wife Valerie and sons Andy (5) and Cory (2). . . . **Gerald Masek**, his wife Cindy and their three children have relocated to Yardley, Penn. Gerald has the position of manager of medical systems for Roche Medical Electronics in Cranberry, N.J. . . . **Calvin Yee** tells us that since the spring of 1977 he has been associated with Federated Department Stores in Cincinnati. He manages a project/systems team currently developing manpower planning and scheduling applications.

Finally, a personal note. Barbara and I are on our way to the mountains for a week-long backpacking trip. We will be hiking over 12,000-foot Mono Pass in the Sierras, just north of Bishop, Calif., and down Mono Creek. Our packs are packed, and our fishing gear is ready. I can almost smell the trout frying in the pan. More news next month. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

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I am sitting at the typewriter in 90-degree July heat putting together the October issue. You, too, should plan ahead — for our fifteenth reunion, the first week of next June. Save those dates!

The Class Hero this month is **Chris Ebbe**, who wrote from sunny but smoggy Southern California, where he is still with the San Bernardino County Department of Mental Health, now as director of their clinical psychology doctoral internship program. Chris enjoys back-packing, canoeing and other outdoor pleasures of the area.

Andrew Heymann recently moved to East Lyme, Conn., working as a resident engineer for General Electric Knolls Atomic Power Laboratory. . . . Recently promoted at M.I.T. were **Richard Larson**, to professor of electrical engineering and computer science and of urban studies and planning; and **Jeffrey Meldman**, to associate professor in the Sloan School. . . . **Daniel Diamond** was promoted to manager of office automation marketing at Honeywell in Billerica.

Jim Bochnowski

. . . Also promoted was **James Bochnowski**, to president and chief executive officer of Shugart Associates, of Sunnyvale, Calif., manufacturers of computer disc storage devices.

Finally, we must note the recent death of **John W. Hafstrom**.

That is it, dear people. The Hoffers now have a salt-water aquarium, and I could fill a column with

tales of warring hermit crabs and of force-feeding anemonae, but I would rather you wrote. — **Edward P. Hoffer**, M.D., Secretary, 12 Upland Rd., Wellesley, MA 02181

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Stephen Ward is currently an assistant professor of electrical engineering and computer science at M.I.T. . . . **William Carter** is a production area manager with Rohm and Haas Delaware Valley, Inc., and lives with his wife and three children in Medford, N.J. . . . **Tom Grover** is developing a kidney dialysis machine for Cobe Laboratories in Lakewood, Ill. He spent last winter training for an assault on the world's best powder skiing area in Alta, Utah. Tom didn't mention whether he is into skiing aerobatics, but who knows, he may get into that too.

Paul Kebabian writes that he has chosen the serenity of Acton, Mass., to continue his home life in peace and quiet. That probably means that he, like **Sumner Brown**, has bought a quaint New England home. I have always loved children, especially other people's children. So, it is with special pleasure that I write to you about two births in the families of our classmates **John Adger** and **Juergen Hahn**. John Bailey Adger, III, was born January 5, 1979, and Evan Hahn was born in March, 1979. Evan is the fourth child for Juergen.

As always, I am in Rockville waiting for your correspondence and trying to dream up things to write in this column that will both improve readability and escape editorial censorhsip. Any new ideas would be gratefully welcomed. — **J. Patterson**, Secretary, 1403 Gerard St., Rockville, MD 20850

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Richard Haberman has moved to Dallas to become Associate Professor of Mathematics at S.M.U. . . . **Ted Williams** and his wife Karen celebrated their first wedding anniversary in July. They are now living in Vienna, Va., where Ted is the head of Ocean Systems at Pro-Energy Analysis Co. Karen is a sales agent with Pan Am in D.C. . . . **June Paradise Maul**, who received her Ph.D. in science and education from Rutgers University in January, is presently working in the Department of Coastal and Environmental Studies at Rutgers. She and Husband Mike (1963) raise Belgian sheepdogs. . . . **Al Falco** is a structural design engineer on the Mod-Z wind turbine for Boeing Engineering and Construction in Seattle.

Richard Cunningham announces the birth of his sixth child on May 10th. He is serving in the Connecticut State Senate (R-Stamford) . . . The **Markus Zahn** family is expecting their fourth child in December, 1979. Markus was promoted to full professor in the Department of Electrical Engineering at the University of Florida in 1978 and has just had a text published by John Wiley entitled *Electromagnetic Field Theory: A Problem Solving Approach*. He is also General Chairman of the Second International Conference on Magnetic Fluids. . . . **Stephen Metz** decided to branch out into something new and is now in his first year of residency in OB-GYN at Bethesda Naval Hospital. . . . **Geese Mase** is living in New York and teaching math and physics at the Brearley School where he has just installed a microcomputer system for student and faculty use.

Mike Schiff recently joined Compo Industries of Waltham as corporate manager of information systems. He and wife Kathy celebrated their fifth wedding anniversary in June. . . . After receiving a Ph.D. in applied physics from Stanford, **Joseph Revelli** spent a year in France at the Universite Paris-Sud at Orsay and two years at Northwestern University. He is currently working on electro-optic laser printing devices for Xerox in Webster, N.Y. . . . **John Toivonen** married Holly Boyd of Santa Monica, Calif., in February. He is assistant professor of chemistry at Santa Monica College. . . . **Christopher Reeve** writes that he is managing a project in distributed database management at the Computer Corp. of America.

Alan Hirsch is working as senior staff evaluation and planning analyst in the computer department of Standard Oil of Indiana. His extracurricular activities include a float trip down the Grand Canyon last summer and singing in the Chicago Symphony Chorus, as well as acting as director of District 8 of Tau Beta Pi. . . . Jan and **Dave Sanders** announce the arrival of their second child, Ann Michelle, in March. Dave is currently managing the marketing staff activities for Hewlett-Packard's Computer Systems Group in California.

Joe La Breche is executive vice president of Mission Investment Trust ("M.I.T.", but no relation), a real estate investment trust in San Diego. He is enjoying southern California with wife Betsey (Simmons '69) and twenty-month-old son Ben. George occasionally sees **Bill Dix**, who is with Gulf Minerals in Denver, **Don Paul**, a geophysicist with Standard Oil in Houston, **Greg Jerrell**, an electrical engineer with Continental Controls in San Diego and **Rich Thurber**, president of his own software consulting company in New York City. . . . **Steven Powell** writes that after graduating from M.I.T. he went to the University of Southern California where he was a lecturer for three years and received a Ph.D. in electrical engineering in 1973. After spending three years at Bell Laboratories, he received an M.B.A. in finance from Columbia University in 1977. He is now Director of Corporate Planning for American Express in New York. — **Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

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Hello again as we start our twelth season here on the pages of the *Review*. We had a very busy summer that started off with a two-week trip to Greece and the Aegean islands in May. While there we had a nice talk with **Yianna Pyrgiotis**, who lives in Athens and works for the Greek government in city and regional planning. . . . From **Herb Finger** we hear of two births. First Herb and Ilene became the parents of Randall Eric, their first child, on February 5, weighing in at 8 lbs. Leslie and **Steve Swibel** became the parents of Laura, their second child, in December, 1978. Herb adds, "Babies seem to be getting popular these days." **Andrew Jennings**, who has written about the birth of a second son, William, on July 23, 1978, would have to agree.

After graduating from the 'Tute, **Richard Raysman** worked for I.B.M. for several years. He then decided to go to law school and is now in practice in Manhattan, where he specializes in law relating to computers and the computer industry. He is the chairman of several bar association subcommittees in the area of computer law and has had several articles published in law journals on the subject. . . . In the same field, we hear that **Walt Oney** is a member of the Massachusetts bar and in September became an associate in the corporate law department of Nutter, McClennen, and Fish, a Boston law firm. Marty Buxton Oney, his wife of 9 years, received a J.D. degree from Suffolk University Law School evening division in June 1979.

David Kaye writes that Nancy, Miranda and he recently visited **Steve Kanter**, his wife Dory, and their son Jordan in Portland, Ore. Steve is teaching law at Northwestern Law School in Portland. David teaches law in a warmer clime — A.S.U. Law School in Tempe, Ariz., although he misses Oregon and goes back often. He adds that last summer he visited **Alan Pollack**, who is a psychiatrist, his wife Laina, and their two children in Newton Centre, Mass. . . . At the University of Rochester, **Arie Bodek** has been awarded a Sloan Fellowship for Basic Research. He is an assistant professor of physics and astronomy and works in experimental particle physics, especially neutrino and hadron interactions. . . . In the never-leave-Cambridge department, we have two items to report. At a certain well-known institute of technology, **Carl Martland** is "still" a research associate in the civil engineering department working in freight transportation. His wife, Nancy, is acting director of the Brookline Cooperative Nursery School. . . . Across town, **Robert MacDonald** has finished the first year of the Harvard M.B.A. program and notes that 11 per cent of his section were M.I.T. alumni. In his spare time, he is a reservist and flies as a navigator for C-130s at Westover A.F.B. . . . **Don Batchelor** is working for O.R.N.L. doing theoretical fusion research on elmo bumpy torus. He notes with interest the growth of physics at M.I.T. (he even "donated" his thesis advisor, Davidson) and plans to visit M.I.T. at A.P.S. time this year.

Louis Crain is currently manager of software products for Prototype Development Associates, a small employee-owned high technology engineering company in Santa Ana, Calif. They have just finished the development of a new product — a three dimensional, interactive graphics, structural pre-processor called PDA PATRAN-G. Louis lives in Irvine with his wife, Connie, and their son Brandon. . . . Closer to home, **Jack Bowie** has moved to Virginia and is working at nearby MITRE Corp. on health information systems. . . . Fran and **Bob Terry** now live in Columbia, Md. After completing his Ph.D. from Johns Hopkins in July, 1978, Bob joined the plasma radiation group at the Naval Research Lab. Fran continues her career at Union Memorial Hospital's Custis Hand Rehabilitation Center. . . . **John Barravecchio** finished medical school at Georgetown University and is doing an internship in internal medicine at Carney Hospital in Dorchester, Mass. . . . From Poughkeepsie, we hear that Marilyn and **Ron Rosen** have switched jobs and now work as programmers at Marist College. They have also started a separate business, Rosen Associates, doing computer software work.

Should you be looking for a physician who is a classmate, we have three widely varying practices to report. First, **Stanley Hoffman** opened a practice in dermatology in January, 1979, in Hillsboro, Ore. He was married to Elizabeth Buker, Vassar '68, in 1970 and graduated from N.Y.U. med school in 1974. They have two sons, Daniel (5) and Benjamin (2), and were expecting a third child when last heard from. . . . Loretta and **George Goldmark** live in New City, N.Y. where he has started a practice in orthopedic surgery. . . . Moving north, **Alan Covey** has a family practice in Newport, Vermont with special interest in hypnosis (emphasis on smoking and obesity programs) and the health benefits of distance running. He got direct experience in the latter by running a marathon last May. . . . That's all we have for this month. Drop us a line with your news. — **Gail** and **Mike Marcus**, 2207 Reddfield Dr., Falls Church, VA 22043

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As predicted, the reunion was enjoyable. The last order of business at the Sunday brunch was election of officers for the next five years, with the following results: **Laura Peterson** — President Emeritus; **Mel Basan** — President; **Peter Peckarsky** — Vice President; **Robert K. Wiener** — Secretary; **Ross Hunter** — Treasurer; **Dean Musgrave** — Portfolio Manager; and as Class Agents — **Bob Pokorny**, **Kathryn (Kanarek) James**, **Nory Haas Jones**, and **Dean Musgrave**.

Thomas Najarian is still news. The June 24 Boston Sunday *Globe* ran an interview and photos regarding his testimony at a recent Senate subcommittee hearing. . . . **Alan S. Willsky**, associate director of the Laboratory for Information and Decision Systems at M.I.T., was named the recipient of the American Society of Civil Engineers' 1979 Alfred Nobel Prize. . . . After spending three years of religious study within Scientology, **Bob Anderson** is now working as a scientific computer programmer for Xerox Electro Optical Systems in Pasadena. . . . **Mark Katz** completed specialist's training in periodontics at B.U. Dental School this June, and has started practice in Bakersfield, Calif. His wife Ethil is expecting their first baby in January.

Bruce Glabe was recently, elected Controller of Bolt, Beranek and Newman Inc., of Cambridge. He's been working there since 1975, has a

Harvard M.B.A., a wife, and two daughters, not necessarily in that order. . . . In July, **Mark A. Rockoff** completed 18 months of research at U.C. San Diego, studying methods of reducing the neurological impact of cardiac arrest. He is now back in Boston at Massachusetts General Hospital on the staff in both the Anesthesia and Pediatric Departments. "Most importantly," he writes, "I got married last year to an M.G.H. nurse and we are expecting our first child any day." . . . **David C. Hill** headed west last year with his wife Rosanne and children Lisa (5) and David (2). He is now manager of exploratory research for Occidental Petroleum Corp. in Irvine, Calif. . . . **Roozbeh Chubak** was promoted to vice president at Vicom Associates, a San Francisco advertising agency. He and his wife Marianne Gerson, M.D., are "enjoying our new baby, Jessica, born 3/31/79."

Peggy and **Bruce Parker**'s second child, Margaret, was born in June, 1978. Bruce is now in the marketing department for Satellite Business Systems. . . . Cookie and **William Bengen** are expecting their first child in August. He also writes, "Drucker, the management expert, is my new hero and his latest book my Bible. Why did I ever think management is dull?" . . . Currently in a residency in neurology, **Stephen Nadeau** became the father of a third daughter, Leslie Danielle, on September 13, 1978. . . . Audrey and **Hans Polzer** have a second son, Robert Bennett, born March 6. Hans was recently promoted to Washington, D.C., branch manager for Operating Systems, Inc. . . . **Marc Davis** is still living in Cambridge and was recently appointed associate professor of astronomy at Harvard.

After stints as a post-doc at U. of Arizona and Caltech, **Ben T. Huie** is now working at Filtrol Corporation in L.A. making catalysts. He writes "L.A. is as smoggy as ever, but it sure beats shoveling snow in Boston." . . . **Chris Ryan** recently resigned his former position and formed a new company, Geo-Con, to do specialty foundation contracting. He "just bought a new home and am re-marrying next September." . . . Last September **Thomas Stewart** "married a beautiful woman, Martha Castillo." Tom, Martha, Martha's 6-year-old son Michael, and their three cats are alive and well in Palo Alto. . . . **Eugene F. Mallove** started Interstellar Enterprises this year, "dedicated to the development and marketing of astronomy-related products, including a complete line of telescopes. " Based on Route 16 in Holliston, Mass., at the "Starquake Astronomy Center" they have already constructed once astronomical observatory.

D. Stephen Weinberg has begun the M.I.T. Artscience Resource Fund and suggests that anyone wishing to donate should contact T. R. Henneberry at the Institute. . . . When **Michael P. Bruce-Lockhart**'s employer went bankrupt last year, he started his own instrumentation company. "Six employees and several contracts. Had to close after six months when one of my key backers dropped out due to financial problems; but broke even and a great experience." Mike is now an associate professor of engineering at M.V.N. and manages to continue his hockey and sailing. . . . **Charlie Schwing** reports that he is "back in the teaching game — math and physics." He and Ann went commercial fishing in Alaska this summer, looking for "plenty of salmon."

Well, it looks as if I've made the first of 60 deadlines. Help me to keep it up by sending letters and notes to — **Robert K. Wiener**, Box 27, M.I.T. Branch, Cambridge, MA 02139

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Variety has been added to our class activities by **Steven Girshick**. He is attending Stanford for an M.S. in mechanical engineering, but only after marriage; two sons; a creative writing program; 7 years in the library; an M.S. in library science and work as an Assistant Engineering Librarian. . . . I received a letter from **Wesley Moore**, who is President of M.I.T. Club of Puget Sound. He saw **Jeff Gale** who is Assistant Professor at the University of Washington in the Business Department. His plans include air shows and bicycling in Europe, not to mention a warning that all his friends better attend the ten-year reunion. — **Robert Vegeler**, Secretary, Kennerk, Dumas, Burke and Backs, 2120 Ft. Wayne National Bank Bldg., Ft. Wayne, IN 47802

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Thanks to **Grethe Holby** (98 Greene St., NY 10012) we have some news. Grethe writes: "I was recently awarded a year-long grant from the National Opera Institute to be an apprentice stage director in opera. I will be working all year with two directors, following them wherever they go, from California through N.Y.C. and on to Brussels and Amsterdam. My directors are Cynth Averbach and Rhoda Levine. The grant began July 1 at Lake George Opera Festival, where I worked on Don Giovanni from July 1-August 10. This past spring (May) I had a dance concert in N.Y.C. with my dance company: Grethe Holby and Dancers at The Kitchen Center. It was successfully received with reviews in the *New York Times*, the *Soho Weekly News*, the *Village Voice* and the *Hudson Review*. I am hoping to take my company to Amsterdam this coming year and maybe someday even M.I.T. will want me back." Grethe asks for news of Anne-Grete Hesnes.

Congratulations, Grethe, on your success in the arts. I hope some of you can see her work.

Since there is no other news, I have to report that being a daddy is great! Please write and tell your classmates where you are and what you are doing. — **R. Hal Moorman**, P. O. Box 1808, Brenham, TX 77833

72

This month to start with we have a couple of classmates promoted back at M.I.T.: **Rafael Bras**, who is currently living in Lexington, has become an associate professor of civil engineering. His research is in the field of surface water hydrology with emphasis on the treatment of rainfall and runoff as random processes in space and time. . . . **Nathaniel Mass** is a new associate professor at the Sloan School. His work is on computer simulation techniques applied to the search for solutions to complex socio-economic problems.

In other news, **Peter Welling** was married to Paula Burgess in Somerville on May 26. He is working at Draper Labs. . . . **Maury Goodman** has received his doctorate at the University of Illinois and is working at Fermilab. — **Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

73

My monthly letter from the *Review* had no mail at all. I almost expected a funeral notice (Class, Graduating, 6, after lingering illness). But I know you're there.

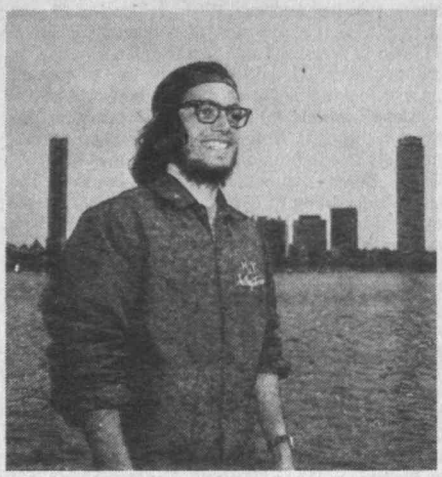
Tony Scandora, '75, is, I know. He entertained your weary hero with complaints of a lost T.R. subscription. Again I remind you — tell fellow '73s they must pay after three years — write T.R. for details.

I am also here. And if you don't like seeing bills be your only mail, you can sympahtize with me. Sympathy to be directed to — **Robert M. O. Sutton**, Secretary, 2005 Cedarwood, Carrollton, TX 75006

74

Hello there. I'll bet you're surprised to see a column here two issues in a row. Now that we have two class secretaries, you should be surprised every issue from now on. I'm going to devote my column this month to the people I met and spoke with at our reunion.

Sandy Yulke, wearing her "Women Multiply at MIT" T-shirt, was elected class president (as you know) for the next five years. Sandy is an environmental engineer at Camp, Dresser, and McKee here in Boston, and as president she has set out to encourage people in our class to get together socially more often. The reunion certainly showed that the desire is there. Of work, she says: "I don't know anything about computers but spend my whole day interfacing with computer poeple. I really enjoy it. They tell me what they can do, then I tell them what I want."



Steve Cucchiaro '74, a two-time sailing all-American at M.I.T., won a gold medal for most total points in the 470 class of sailing competition at the Pan American Games this summer in Puerto Rico. The Beverly, Mass., native finished more than four points ahead of his nearest competitor in the seven-race regatta. According to M.I.T. sailing coach Harold Brown, Cucchiaro is a leading candidate to represent the U.S. in his class at the Olympic Games next year in Moscow. Cucchiaro captained the Engineer squad in 1974.

Marty Davidoff takes over the job of class treasurer from **Dennis Dickstein**. Marty and Sheila just recently moved to East Brunswick, N.J., wherefrom he commutes to New York City to play tax attorney. Marty would like you all to know about the Class of '74 gift: out of funds we have donated to the Alumni Fund as "undesignated," $10,000 has been given to the Athletic Association for the renovation of five baseball diamonds on Briggs Field. Two of these will be first-class fields with special infield surfacing and one of those two was to be christened the "Class of '74 Field" in ceremonies this September. Part of the funds donated, along with other monies released when our contribution was made, will be set aside for maintenance of the fields for years to come. And speaking of the Alumni Fund, your friend and mine, here are some interesting statistics concerning our class' generosity: in the five years since our graduation, our class has donated a whopping $35,283 to the Fund — and all from only one in four class members. So remember that even if you haven't ever given to the Alumni Fund, there are a large number of people who have, generously. The average yearly gift works out to be $18 per contributor.

I just caught **Abbie (Rubin) Gregg** eight days before she and Rand moved to Phoenix. Leaving National Semiconductor, Abbie is now the yield enhancement manager for Motorola's HMOS semiconductor line. . . . And speaking of good-looking people, **Hillary Morgenstern** starts the New England College of Optometry in the fall. . . . And speaking of doctors, **Paula Elster** has received her M.D. from Cornell Medical School and is starting her internship at Roosevelt Hospital in New York City.

I tried to reach **Ken Skier** on the 'phone but he was up in Vermont on a one-week bicycle trip along the Connecticut River. . . . **Rod Taft** just bought 51 acres of land in (of all places) Taftsville, Vt. Rod is seriously planning to build a house on the property — not for himself but to rent to people looking to live in the Woodstock area.

Steve Jordan is a marketing manager for Mostek. He and Sue were two of the furthest-travelers to the reunion, coming all the way from Dallas. Steve spends his spare time "watering the lawn and waiting in line for gas, but only on the even days." . . . **John Pearson** is building an energy-efficient hot water heater for NMTI here in Newton. He and Valerie just moved into a new house in Maynard, Mass.; their second of two girls was born in April. . . . **Ken Green** is in the home stretch in pursuit of his Ph.D. in geophysics at Woods Hole. He will be going to work for Exxon in Houston as soon as he finishes his thesis, which will probably be in September, October, November, December, or 1980. . . . **Bruce Judelson**, who was chairman of the class reunion, is a tax attorney for Nutter, McClennon, and Fish in Beantown. He and Debbie recently moved into a new home in Wellesley. . . . **Steve Nuding**, after receiving his S.B. in nutrition, spent two years at the Boston University School of Drama. You may remember seeing Steve as King Arthur in *Camelot* our senior year. He is now touring the country in the National Touring Company of *Oklahoma!* playing Curley (that's the lead, boys and girls — Gordon McRae in the movie). Mickey was expecting their second child in early August. They've played to packed houses everywhere and if the U.N. Ambassador to China likes the show when they play in Washington, D.C., it's off to you-know-where for more performances.

According to an article in the Boston *Globe* recently, one out of every 400 people in the United States is a millionaire. I realize that we are not exactly a random sampling of the American population, but are there any millionaires out there yet? Why don't you write me a note, say on the back of a $100 bill, and tell us how you did it?

Ron Kuppersmith founded Computersmith, Inc., a computer software firm. He and Diane celebrated their one-year wedding anniversary in May. He spent the entire spring slaving over the reunion, and if you're looking for him, he can be found at his own table at Cityside in the Quincy Market, downtown Boston. . . . The M.I.T. radio station has changed its call letters. **Jay Krone** tells me that Ted Turner called up WTBS and offered then a $50,000 package deal for the purchase of the call letters for his Turner Broadcasting System in Atlanta. Much of the money has been spent on equipment mandated by the F.C.C., and the station's new call sign is WMBR (Walker Memorial Basement Radio).

Janet Markham returns to the States after spending five years studying at Imperial College, the M.I.T. of Britain. She's working at Bell Labs in New Jersey. . . . Finally, **Steve Cucchiaro** was awarded a gold medal in the 420 sailing event at the Pan American Games and, according to an article in the *Globe*, is "a likely Olympian."

Lost and Found: Will anyone who knows the whereabouts of the following people please send in some news about them : **Joe Walkush**, **Karen Wahl**, **Jim Andrew**, **Tom Wolff**. The purpose of this column is for you to see your name and the names of people you know in print. It's as simple as that. So drop us a line and tell us how you're doing. Jim and I will be writing this column on alternate months. Gossip, rumors, and pure fiction are also welcome. Write, okay? — **Lionel Goulet**, 34 Tremlett St., Dorchester, MA 02124; **Jim Gokhale**, 6 Burton St., Arlington, MA 02174

75

We have a short column this time but it's filled with happy news. **Curt Terwilger** wrote to say that he and Caroline Bergh (Stanford, '76) were married on June 30 at Caroline's parents' place in North Ferrisburg, Vt. Caroline just got her M.B.A. from U.C.L.A. and is working for H.E.W. in San Francisco while Curt finishes up his Ph.D. in electrical engineering at Stanford. After he gets his degree, he'll work full-time at Cromeco, Inc., where he's been doing consulting for the last three years, doing circuit design. Former Bexleyites **Mike Conner**, **Marc Majewski** and **Paul Averbach** attended the wedding. Mike just got his D.V.M. from Georgia and his wife Barbara recently had a baby. Also present were Peter Greer, '70, and Jim Spooner, '71. Curt and Caroline are living in Burlingame, about 20 minutes south of San Francisco. They stopped in Boston at the end of their honeymoon and toured M.I.T. "Bought a shot glass for a souvenir, too." Thanks for writing, Curt.

Chuck Digate was recently promoted to Controller of Time Products Division of Texas Instruments in Lubbock, Tex. — "a real opportunity to turn a business around." . . . **Pat Callahan** is living in and loving San Francisco, working for Crocker Bank as a manager in the Operations Division, "pretty far from mechanical engineering." . . . **Holli Jones** is working for Polaroid Corp., Sesame Division in Norwood, Mass. as a technical supervisor in the analytical lab. . . . **David Wargo**, whom I occasionally run into at duPont Gymnasium, is working for the State Street Research and Management Co., in Boston, in the area of investments, after having gotten master's degrees in nuclear engineering and in management from Sloan School, at M.I.T. . . . **F. Patrick Schultz** recently joined Comperwood Interests, a real estate development firm in New York City and Houston, Tex.

I also heard from **David Strauss**. He and his wife Liz had a nine-pound baby boy, Jacob Alo, on June 10. David also informed me that there was an error in the June/July issue. David works for Teradyne, not Terredyne, in Boston where he is an electronics design engineer.

That's it for now, folks. Remember, we've got a reunion coming up in June. (Has it really been five years already?) We're in the process of putting a reunion committee together at the time of this writing. Any input? Let us know. Keep writing. — **Jennifer Gordon**, 22 Centre St., Apt. 9, Cambridge, MA 02139

76

Due to a lack of mail, these class notes are a bit scanty.

During the last fundraising telethon, I learned that **Kathy Whitney** is in her last year at veterinary school. . . . **Michelle Petrofes** is entering her last year at Harvard Medical. At the time of my call, she had just finished being a juror for a trial, which she found to be a fascinating experience. As part of her medical education, she will be going to a Colombian banana plantation for a rotation in tropical medicine.

Carol Santa Croce married Dr. Robert Reitano in October of 1976. She is an actuary with John Hancock and has only two more exams to go. . . . **Neil Gern** is going to be at the University of North Carolina, Chapel Hill, studying statistics and rooting for the Tar Heels. . . . **Michael Smolinski** is in the Energy Group at Data Resources in Lexington, Mass. . . . **Bill Castellani** is to be found at the University of Michigan Medical School. . . . **Charles Poirer** is currently a driver for the E.P.A. auto emissions program. Starting this fall, he will be going to Duke University grad school in computer science. . . . **Tony Lake** is located at Bolt, Baranek & Newman. . . . **Mark Crane** has told me that he has "legitimately graduated from Sloan!"

At my office, I received a call from **Roxanne Ritchie**. She is working for R. J. Pittman and Associates, an employment recruitment firm for data processing people. On August 25 she is marrying James Van Bokkelen, '78, and will be living in Allston. She informed me that **Wendy Peikes** has just bought a home in Sunnyvale, Calif.

While coming back from visiting a client on Commonwealth Ave., I had the pleasure of bumping into **Silke Schweidt**. She told me that after graduation she worked at New England Nuclear until July, 1978. From July to November of that year, she went to Europe to travel and explore, and then, shortly after getting back, went to work for the Shriners Burns Institute doing research. It was a great surprise seeing her, and I think she was surprised to see me as well.

I recently received a delightful postcard from **Margaret Hainsworth** featuring a family of five St. Bernards (complete with brandy casks). Margaret spent a week vacationing in France and Switzerland.

This story about a classmate of ours comes from Cheryl Allen '78. Cheryl was visiting her classmate Linda Roux in New York City, and they went to see a movie — "The Wanderers." Their conversation during the movie went something like this — Cheryl: "Look at the size of that guy. You know, he looks a lot like **Erland van Lidth de Jeude**." Linda: "Funny, he even sounds like Erland." As the credits rolled across the screen, they shrieked together, "IT IS ERLAND!" Cheryl told me he looks simply frightful in his role as "Terror." I will try to catch the film and give you a report in the next class notes.

As for your secretary: I've been having quite a time in the precious metals markets. We have witnessed and participated in record highs — and now, we are enjoying the glory and profits of short sales in the gold, silver, and platinum markets. Reflect on this — in my business, a recession is a wonderful event! Unsettling, isn't it? — **Arthur J. Carp**, Secretary, Endymion Commodities, Inc., 131 State St., Suite 616, Boston, MA 02109

78

You are probably reading this as the first cold snaps of fall approach. How poetic. Well, I've got to fill up space somehow when I don't have much news. So once again I put out a desperate plea for news: tell me that your goldfish had kittens, or that your boss did; tell me how going to California has changed your life, or that you were there when Yastrzemski hit his 400th homerun. But tell me something.

California has changed **Earl Cohen**'s life. Earl, once known as a great cook of lasagna and roast beef and other carnivorous delights, has become a vegetarian while studying at U.C. Berkeley. More shocking to those of us who know him since freshman year, he has taken up a strenuous exercise regemin. He also enjoys California's hot tubs. I asked Earl if he was now mellow, and he responded that he's not mellow, he's "ripe." (I just can't keep up with this California jargon.) Earl was in Cambridge for a short trip east, staying at the apartment of former roommate, **Jon Sieber**. Jon is an E.E. grad student at the 'Tute while doing consulting work for Bell Labs.

I just got a call from **Sue Coppersmith**. Sue spent the last year at Cambridge (the one in England) and will now be returning to school in the states. She'll be a graduate student in solid state physics at Cornell University in Ithaca, N.Y. A few weeks ago Sue called to tell me about the marriage of **Dave Karp** and his hometown girlfriend Corinee Sieracki. The marriage took place in the chapel at Case Western Reserve with **Vinny Paolino** as usher and **Rob Indik** as best man.

From **Geoff Baskir**: "It had to happen. I got kicked upstairs. Yesterday, I was sent out of Stamford, degree in hand, to enter the working world. I'm going to be staying in the Bay Area. I got a job in airport planning with Peat, Marwick and Mitchell, and they're keeping me pretty busy. **Nino Pedrelli** and **Rich Zingarelli** also got their masters in civil engineering. Rich tells me he's heading back to Boston, while Nino is going to be working in Cleveland, of all places. . . . Graduation ceremonies at Stanford were something else. The undergraduates all walked into the ceremonies with champagne bottles under their gowns. I've never seen so many corks flying through the air — like fireworks. When the President of the University remarked, 'I see yo're all in good spirits,' everyone in the front rows raised a bottle or a glass. . . . " (California, huh. I can't tell if that's mellow or if it's ripe, like Earl.)

From **George Whittinghill**: "After graduating, I left for South California to marry the prettiest girl

in the state (of course), Judith A. Bensen, and left for Bermuda on our honeymoon. A month later, I started to work for McDonnell Douglass in Huntington Beach, Calif., on the Ballistic Missile Defense program. Come spring, they had transferred me to Kwajalein Missile Range, Marshall Islands (in mid-Pacific) as a systems analyst. Upon completion of my tour of duty I hope to return to grad school, if I can ever readjust to cold weather."

John Jaynes just graduated from the joint service training at Mather Air Force Base and now hopes to be stationed at Moffett Naval Air Station to fly for the Navy. His wife, Martha Yarber, '79, just started working for Hewlett-Packard in the San Francisco area. . . . **Peter Brobbey** wrote to say how much he was enjoying U.S.C. and the Southern California summer weather. (Now *that* sounds mellow.)

From **Bernie Alpen**: "Greetings from the land of Israel! Since finishing my studies at M.I.T. at the end of 1977, I have been at the Haifa Technion, studying for my M.S. in traffic and transportation engineering. I love Israel — the land and the people — and urge all of our classmates to come visit. Personally, I am seriously considering settling here permanently, but nothing is definite yet. . . . By the way, I have seen classmate **Maurice Halmos** here at the Technion — he is studying towards his M.S. in E.E."

"The Relationship of Lipid Metabolism to the Control of Circadian Rhythmicity in *Neurospora Crasa*" That, I am told, will be the subject of **Gary Cote**'s thesis for his masters at U.C. San Diego. Translated, it means that he's trying to find out how a mold tells time. This summer he took a course at Stanford University's Hopkins Marine Station on Monterey Bay, studying biological clocks. Gary describes California as "the land of surfboards, hot tubs, cults, and the country's next defeated presidential candidate (I hope)."

Stella Perone writes, "I finally decided I should get ambitious and get my name published in *Technology Review*." Stella's working for General Atomic Company in San Diego and is really enjoying it. For a former tennis team member, the place sounds ideal, because "the two tennis courts and swimming pool on site (which is *very* close to the beach) do contribute."

Ruthie Shragowitz wrote to report on a recent trip to — where else? — California. First stop: Berkeley. **Rich Perlstein** is out there, studying for his M.Arch. at U.C. Berkeley. Rumor has it that Rich might be trying to come back to Cambridge in the fall to work for a year before finishing school. **Eric Palson** is also studying for his M.Arch. out there; his summer plans were to take a trip to Turkey to document archeological sites. **Vonetta Clark** is in the same program, but Ruth was unable to find her. She did run into **Lee Gavens** who's a graduate student in chemical engineering at U.C.B. but will be returning East for the summer. (By the way, Lee: You have an incredible look-alike at the University of Michigan. Every time I see the guy I wonder what you're doing in Ann Arbor). Ruthie also reports that **Scott Chase** is working in an architectural firm in California, but was in Boston on vacation when he ran into Ruth; and **Scott Bernard**, who's at U.C. Berkeley Law School, is working in Boston for the summer. When Ruth was in Menlo Park/Palo Alto **John Little** and **Paul Limburg** threw her a big party which Ruth says was reminiscent of Burton Third Bombers' Blasts. John, who'll be working in the East this summer, and Paul, who'll be working in Santa Monica, were both engineering grad students at Stanford. Ruth is still living and working in Baltimore, employed at an architectural firm called R.T.K.L. Associates, Inc., and I've heard rumors that she's thinking of graduate school, though her letter didn't say.

A note to **Milt Roye**: You've apparently caused the Alumni Association a great deal of confusion. First they couldn't figure out how to spell your name. And when they finally got that straight they got two change of address forms from you — with two different addresses! They've finally come to the conclusion that you live on Stonecastle Drive, instead of Stonebridge Drive. (Milt's working for the Delco Products Division of General Motors

Erland van Lidth de Jeude (6'8", 415 lb.), '77 as "Terror," leader of the Fordham Baldies, in the movie "The Wanderers" with his lady Pee Wee played by Linda Manz (4'10", 83 lb.).

Erland van Lidth de Jeude, '77: "Terror" in "The Wanderers"

On August 1 "The Wanderers" opened in Boston. That evening I went to see it at the Saxon, with about 15 M.I.T. students and one alumnus wearing a studded leather jacket — Erland van Lidth de Jeude, '77, known to those who have seen the movie as "Terror."

Erland was working as a systems analyst and programmer for Citibank in New York City when he was contacted by the film's staff. Erland, a super heavy weight wrestler, is a member of the New York Athletic Club who gave the movie producers his name when they came looking for "big guys." Erland who stands six feet eight inches and weighs 415 pounds, placed second in the United States Wrestling Federation freestyle national competition and second in one Amateur Athletic City Union Greco Roman Nationals, and is still planning to try out for the 1980 Olympics.

Not hoping for much more than a big guy the movie producers interviewed Erland and found to their surprise and pleasure he could act too! Erland had been an active member of the M.I.T.'s Musical Theater Guild and Drama Shop and had played many roles while at M.I.T. So he shaved his head and became one of the notorious "Baldies" for the seven weeks it took to film the section of the movie that he was in. Erland is now a member of the screen actors guild and will be moving from Brooklyn to New York's Greenwich Village (where many actors and artists live) to pursue a career in acting. — *Beth Marcus*

The Class of 1979 leaves a dogwood tree as part of their gift to the Institute. Class officers and executive committee members are (left to right) Carole Ruegsegger (vice president), Bruce Bornstein, Sharon Lowenheim (secretary-treasurer), Gregg Stave, Debbie Meyerson, and Marcia Grabow (president). (Photograph by Gordon R. Haff)

somewhere in Ohio and he recently purchased a sports car which he's very proud of.)

Sandra Tong writes, "Life in Baltimore is okay — nothing compared to Boston, of course! I'm at Hopkins Med School with classmate **David Potter**. I'll be in San Francisco this summer at U.C.S.F. in the Department of Radiation Oncology. . . . More med students: **Michael Waxman** is at med school at S.U.N.Y at Buffalo, where **Barbara Ostrov** will start in the fall (Barbara will get a master's from Course XX at the end of the summer).

From **Leslie Kostrich**: "Right now I'm finishing up the first year of a two-year master's program in public policy at U.C. Berkeley. I'll be spending the summer in Washington, D.C., at the Department of Labor solving our nation's most pressing problems. All in all, I'm having lots of fun." . . . **Larry Yablong** is working as a management trainee with Gilbane Building Co. as an estimator. In his spare time he is the advisor to his temple youth group, and he works in a program called "Volunteers of Albany" which helps less fortunate communities in the area. I'd like to take a few lines here to thank Larry belatedly for all the work he did for the class last year. In the last hectic weeks of preparation for last year's commencement and senior week we needed all the spare hands we could find, and Larry contributed five or six of his own. . . . **John Gullotti** writes, "I left General Electric in December to take a new position as welding engineer for Thames Valley Steel Corp. in New London, Conn. I'm working for the chief engineer, Sandy Randall, '69, and things have worked out very well, though I rather miss Boston."

Laura Swire writes that she's been working for the General Electric Nuclear Energy Business Group in San Jose since August. . . . **Pete Shaw** writes from Scripps Institute in San Diego to correct my last note about him. He's studying geophysics, not physical oceanography, as I had thought. . . . Pete also mentioned that **Earl Cohen**, who's studying at Berkeley, has lost his brass rat — so keep your eyes open out there. . . . **John B. Dell'Aquilla** writes that he's working for General Motors in Detroit as an analyst dealing with D.P. Security, and that he'll be attending Wharton School of Business in September. . . . **Diana Christman Haynie** is working for General Electric Industrial Medium Steam Turbine Division (call it GEMSTD for short) in the Professional Relations and personnel departments. She got her master's from Sloan in January.

Gary Kurzban is working for F. W. House of Houston, Texas, researching flood and roach control. More power to him — get those little devils! . . . **Dan Zwillinger** writes, "Doing well in applied math at Caltech. Will spend summer working for Sandia Labs in Albequerque." . . . **Thomas D. Y. Chung** writes that he is working for Exxon on a Stanford Industrial Affiliates appointment in Linden, N.J. . . . **Steve Ratliff** is directing a small group of programmer/analysts at Clay Bernard Systems International in Tulsa. They are involved in the design, implementation, and installation of software for the automation of a U.S. Navy facility.

Henry McGrath reports that he has given a number of talks during the past year on the only commercial coal-to-gasoline plant in the world. Located in South Africa, the plant uses a process Henry patented many years ago. It will be interesting to see what develops in the future.

Jeanne Scott is now at the University of Pennsylvania Medical School. Last December she married Patrick Barron, also from M.I.T. . . . **Sue Hanson** and **Karyn Altman** both recently graduated with masters in civil engineering, Sue from Berkeley and Karyn from M.I.T. They'll both be moving to the Washington D.C. suburbs, splitting an enormous apartment with former M.I.T. people like Jim Moody, '75, and Audrey Greenhill, '79. . . . And just to confuse you, **Sue Hansen** will be working as research staff at M.I.T. on a project concerning artificial skin. (Sue Hanson is formerly from Baker, Sue Hansen East Campus.)

So ends this month's edition. I remind you that I am unable to continue writing this without notes, letters or phone calls from you. As for news of your class secretary, my goldfish did not have kittens and I did not see Yaz hit Number 400. Summer in Boston didn't disappoint me: hot, humid, sticky and a lot of fun. Soon it'll be back to Ann Arbor for me. — **David Browne**, Secretary, 1026 Vaughn St., No. 6, Ann Arbor, MI 48104

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Congratulations, fellow graduates!! Welcome to the first in what I hope will be a long series of Class of 1979 gossip columns!

By now I imagine that most of you are out there trying to make your first million by age thirty. Among those of us who are starting that climb up the corporate ladder are **Eileen Mannix**, who's working for Dupont in Wilmington, Del., in the field of elastomers. . . . Ocean engineer **Joan Sienkiewicz** is lending her expertise to American Boat in Groton, Conn. Joan's furnishing her new apartment in "Early Employment"! . . . **Elaine Pope**, a co-op student in the Department of Materials Science, is working on silicon solar cells (say that ten time fast!) for R.C.A. in New Jersey. She'll be returning to the 'Tute in the spring to finish her master's degree. . . . Electrical engineer **Ken Keverian** is also in New Jersey, working for Bell Labs. They'll be sending him back to M.I.T. for his master's degree in electrical engineering in September.

To many of us, the lure of an advanced degree was greater than that of a salary (sob!). **Jan Nielsen** and **Marcia Grabow** are off to Stanford for graduate study in materials science. **Russ Steinweg** will also be there, in the Computer Science Department. . . . **Mark Schafer** is back in his native Pennsylvania studying acoustics at the University of Pittsburgh. Maybe he'll be able to do something about Kresge. . . . **Barry Bayus** is at the Wharton School of Business at the University of Pennsylvania, while **Yvonne Chen** is at a rival school, the Business School at the University of Chicago. Love those three-piece suits!

At a party at the home of Ken Turkewitz, '80, this summer, several class members turned up. **Clay Funkhouser** and **Wes Harper** are both in transportation studies at Northwestern University in Chicago. **Bill Wiehl**, a co-op student in electrical engineering, is working for I.B.M. in Yorktown Heights, N.Y. **Chuck Harm**, another co-op student, is in Pittsfield, Mass. Chuck is taking full advantage of the Berkshires — he was an usher at Tanglewood this summer, enjoying free admission to all concerts. Good show, Chuck! . . . **Mitch Weiss** is in Danbury, Conn. (pop. 60,000), making robots for Unimation. According to Mitch, eight out of every ten robots are made by Unimation. I wonder which company made Mitch! . . . **Scott Macfarlan** refused to disclose his fall plans, but the trench coat and rubber soles sure made me suspicious.

Other co-op students whose faces will grace the hallowed halls of M.I.T. again next February are **Barry Wyshogrod**, who's currently with Hewlett-Packard in Waltham, Mass., and **Mike Patrick**, who's doing his thing for Texas Instruments down in the Lone Star State. . . . Fraternity brothers **Greg George** and **Jim Lester** are both off to Duke University in Durham, N.C. — Greg to the Medical School and Jim to the Law School. **Gregg Stave** is also at Duke, in both the med school *and* the law school. This way he can defend his own malpractice suits!

Congratulations to **Brenda Hambleton** and **John Hopper**, who were married in May, and to **Lee Boy** and **Valynn Knight**, who tied the knot in early June. Let us know how those dual careers work out.

As for me, I'm at the University of Pennsylvania trying to get an M.B.A. from the Wharton School and an M.S.E. in computer and information science in two years. However, I'd rather be reading letters than doing homework, so please keep those cards and letters coming. Anybody who doesn't write will find things made up about them in the next issue of *Technology Review*! Bye for now — **Sharon Lowenheim**, 3600 Chestnut St., Box 1166, Philadelphia, PA 19104

A Good Year for Placement: the Old Salt Mine Looks Like a Diamond Mine

"It's been an extraordinarily busy year," says Robert K. Weatherall, director of the Placement Office. "It's been marvelous."

In all, according to Mr. Weatherall's records, 430 different corporate divisions and government agencies came to interview students in 1978–79. Mostly they came — many of them twice — looking for engineers, although management students were also in demand. It was a good recruiting year at Sloan.

"One recruiter declared coming to M.I.T. was like visiting a diamond mine," says Mr. Weatherall. One Fortune 500 company brought along its president himself to meet students. Other companies arranged parties with drinks and goodies. Some invited Mr. Weatherall to visit them — "if they can't win students directly, they woo whomever they can reach," he explains. They also woo faculty: "A man at Polaroid said the best way to get good chemists is to contact the faculty they know."

It was a good year for salaries: students with a bachelors' degree in electrical engineering averaged $19,000; the average master's student from the Sloan School commanded $26,000 or more.

On the darker side: starting salaries are leaving last year's graduates feeling underpaid. "We've had young alumni come by feeling sorry for themselves — their salaries are no higher than those of the new recruits, and that is of some concern."

The architecture profession has been suffering: there is very little demand. "To have one or two architecture firms come to interview makes us feel like Columbus when he saw pieces of floating vegetation — there may be land ahead."

In the sciences, students are having second thoughts about whether it's worth going for a Ph.D. and then entering the struggle for teaching positions and then for tenure. They know, too, that as faculty they may have more trouble getting research grants.

But none of this means that an impending recession was visible in hiring patterns by mid-summer, when Mr. Weatherall was collecting his 1978–79 figures. That could change — in other years there have been very abrupt changes: a company which recruits in the spring may be forced to lay off people in the fall.

"One recruiter declared coming to M.I.T. was like visiting a diamond mine."

The job search is often a game of chance . . . "I'm struck by the care students use to pick a college — and, in contrast, the little time invested and large element of chance involved when they make what is really a larger decision for a job."

M.I.T. students favor Massachusetts as a place to live. They seem not to be put off by high taxes, and they like the intellectual climate. The east and west coasts are favored; students are less attracted by areas in between. A student in electrical engineering can find a job on the east or west coast; but chemical engineering jobs are concentrated in the southwest or mid-Atlantic states. "I don't know if students realize when they choose chemistry, for instance, they are also choosing a destination away from the northeast," says Mr. Weatherall.

An increased number of engineering students are going with high technology firms that have a commercial market (rather than companies whose prosperity is based on contracts from the government). Many are going to computer companies, Polaroid, and semiconductor manufacturers. The other side to that; students who are engineers are seeing themselves not solely as engineers but as future managers. "We teach students engineering; but what we hope for them, too, is leadership in business."

Students look for a good atmosphere — a fresh style and young leadership. Older companies have a challenge in attracting students who are drawn to new, young companies with an optimistic attitude rather than older firms that have known retrenchment (though they may be very good and well regarded). Examples of such companies: Digital Equipment Corp., Prime Computer, Hewlett Packard, Wang Laboratories, Analog Devices, Data General. They have a young style, they haven't experienced economic setback, and they all have recent histories of growth.

The job search is often a game of chance. For four years the Placement Office has produced a resume book (for $70 to cover expenses) which lists all job-hunting students. Companies study the book in the process of arranging campus interviews. A student may only interview six or seven companies. It becomes obvious he will get an offer, and he's got lots of other things to think about. There are many good companies he knows nothing about. If a company, seeing his resume in the book, invites him to an interview, that may be enough to make up his mind.

No student has more than minimal time to travel. If he has an interview on the west coast, it's a day to get there, a day there, and back on the "red-eye" to face thesis, classes, and the end-of-the-year crunch. Under these conditions, a company like Hewlett Packard has an advantage — students have seen their calculator and laboratory instruments. If the product is totally unfamiliar, attraction may be diminished.

Finally a decision is made. "I'm struck by the care students use to pick a college — and, in contrast, the little time invested and large element of chance involved when they make what is really a larger (potentially life-long) decision for a job," says Mr. Weatherall.

"I'm constantly reminded of how much M.I.T. students have to offer. Their interest in engineering ranges all the way from nuts-and-bolts design to technology policy. A professional education offers a chance to be creative. Some think technology narrow, unimaginative. But here, creativity is *enhanced* by technology, made more real, relevant, and cogent." — *M.L.*

Science Meets Faith as the World Council of Churches Invades the World Center of Technology

For some of the 900 participants from throughout the world, it was a journey to the temple of the devil: "We denounce science and technology," said a group from Africa, Asia, Latin America, and the Pacific.

"Protected by the ideology of objectivity and value-free pursuit of truth, science and technology have been at the service of military and economic interests which have brought about great sufferings to the peoples of the Third World," said their manifesto to the World Council of Churches' Conference on Faith, Science, and the Future at M.I.T.

For other delegates, it was a pilgrimage to a symbol of their aspirations. Fully half of the delegates were scientists and engineers — the largest presence of these professions ever invited to any world ecumenical conference, according to Philip Potter, general secretary of the World Council.

That the conference came to M.I.T. was chiefly due to the vision and persuasion of David J. Rose, Ph.D. '50, professor of nuclear engineering, motivated by a conviction that technology has for too long been too little concerned with its ethics and values. A simple but telling example came from Dr. Rose at a press conference on meeting preparations: "Why does the exhaust pipe of an automobile come out *behind* the passengers?" he asked in response to a reporter's question.

Professor Rose ended up as chairman of the local arrangements committee, responsible for hosting visitors from every continent and nearly every country in the world at the Institute between July 12 and 24. It was no small task. At an outing in Woods Hole on July 22, the visitors and their families consumed 500 hamburgers, 600 hot dogs, 16 gallons each of potato salad and cole slaw, and 14 cases of soft drinks.

Why this deliberately orchestrated confrontation of technologists on the one hand and religious philosophers on the other? Through all the conference meetings, which preempted Kresge Auditorium, Walker Memorial, and many M.I.T. classrooms for nearly two weeks, was the sense of a new view of the world: resources are finite, there *are* limits to growth (and they may be very nearly at hand), and — under these conditions — the goal of creating a more just and participatory future society can hardly be accomplished simply by letting the "have-nots" struggle to achieve as best they can the standards of the "haves."

". . . an Elitist Weapon to Preserve Power . . ."

Three tensions marked most of the conference:

☐ Between first and third worlds in their views of technology.

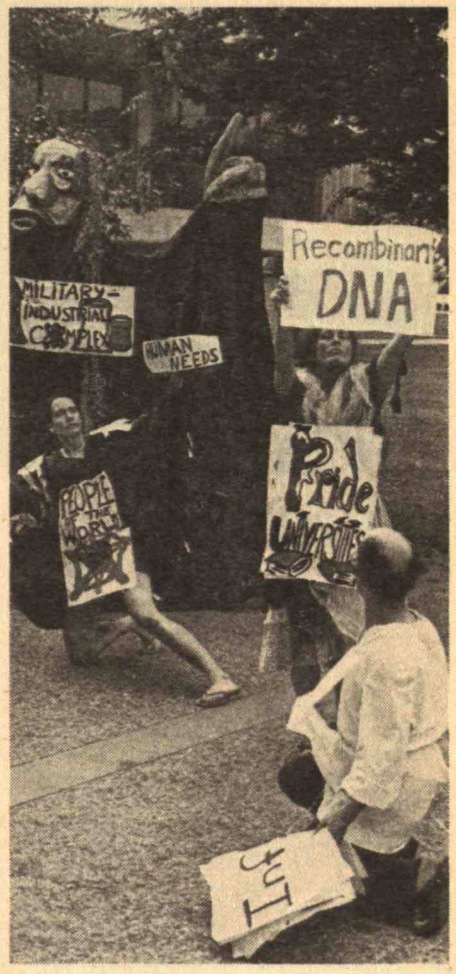
☐ Between "high" and "low" technology in serving the goals of a just and sustainable society.

☐ Between the experimental approaches of science and the philosophical ones of faith.

In his opening address, Dr. Potter proposed that modern science and technology are "biased on the side of those who wield economic and political power." The need, he said, is to make science and technology "the vehicles, not for legitimizing and perpetuating the structures of injustice, but for opening up the possibilities for structures of social control, which include all the people."

Young people from Africa participating in a pre-conference at Wellesley College wrote that ". . . Western capitalism using science and technology has been employed to exploit and dominate countries in Africa, . . . Asia, and Latin America. . . . The indigenous technology has been distorted and destroyed, [resulting] in conflict and underdevelopment."

The students later continued their offensive at a plenary in Cambridge: science education is an elitist weapon used to preserve power and institutionalize values, they said. Professor Rose responded in discussion that



While leaders, paritioners, and scientists of the World Council of Churches (above, Metropolitan Dr. Paulos Gregorios of the Orthodox Syrian Church – India) deliberated inside M.I.T. in July, some vigorous anti-technology messages awaited them outside. Sponsors of some of the latter identified themselves with "Plowshare," a public listening-post/discussion center developed in Ashdown House by the M.I.T. Chaplaincy, the M.I.T. Technology and Culture Seminar, the Fellowship of Reconciliation, and the American Friends Service Committee. (Photos: William D. Hofmann, '80, courtesy of Technique, *and Gordon R. Haff, '79)*

"selective inattention" to certain problems seemed to him a more valid criticism of education. But Joseph R. Egan, a graduate student in nuclear engineering at M.I.T., pressed the original point: too many of his student colleagues, he said, have tunnel vision. They see the internal combustion engine, for example, as simply "the greatest achievement of humankind."

Earlier, Rubem Alves, professor of philosophy at the University of Campinas, Brazil, had told the students that "the marvels of technology acquire their meaning through the logic of economy.

"But economy is a totally immoral game," he said. "It makes no room for human values.

"What were you after when you decided to serve science for the rest of your lives?" Dr. Alves asked his Wellesley audience. "Knowledge? Pure knowledge? But there is no such thing: Science has social existence only through the grammar of economic power.

"To whom are you as scientists going to be delivering power?" Dr. Alves asked. "The obvious answer is: for those who pay the bills. In other words, power is given to those who already have power, to those who are committed to the preservation of the present, which is an unjust present."

The Private Ownership of Life

The most-discussed resolution of the conference was that calling for a moratorium on new nuclear power plants, to be continued until the "overall risks and costs of nuclear power can be fully determined and justified." Professor Rose was among 11 signers of a minority report: "The production of nuclear-generated electricity is to date the safest energy industry throughout the world," they said. And the resolution is "unjust" to developing countries because it restricts nuclear power for at least the next five years to wealthy nations which already have it.

Jonathan King, professor of microbiology at M.I.T., told the conference that "the controversy over recombinant DNA technology is not about freedom of inquiry. The debate is about the regulation of those who want to rashly exploit for private gain the fruits of knowledge which should belong to all peoples," he declared. The inventor of any new physical device can have a patent on it, said Professor King, and under present law the same privilege is given to the inventor of any new genetically-altered micro-organism or plant. He disapproves: "To have forms of life privately owned by any company will in the long run cause many problems," Dr. King said.

Organic Modification by Massive Ingestion

One plenary session of the conference consisted of three papers invited from M.I.T. on issues in information gathering and processing. David H. Staelin, '60, professor of electrical engineering, was wholly optimistic: the capacity of weather, earth resources, and communication satellites to help find answers to global as well as local problems has hardly begun to be tapped.

Thomas B. Sheridan, Sc.D. '59, Professor of Mechanical Engineering, argued less sanguinely: "The time is here, I believe, to celebrate those ways in which people are not computers and let computers take over those jobs where they clearly outperform us." But he reminded his audience that "the ultimate criterion for how and where computers shall be used is subjective and not arrived at through any objective process. I'm not sure the technologist sufficiently appreciates this," he said.

The thesis of Joseph Weizenbaum, professor of computer science and engineering, on "technological detoxification": "Our society has . . . become organically modified by our massive ingestion of the worst fruits of our science and technology." Some signs of addiction: the idea of a "technical fix" for every ill, substitution of people's images for their real persons, the nuclear arms race, and our "insane consumerism."

As the World Council of Churches delegates began packing their bags to go home, scientists and theologians alike joined in prayer:

"Herr Jesus Christus, wir bitten dich, erleuchte all Wissenschaftler . . ." ("Lord Jesus Christ, enlighten, we pray, all scientists . . .")

The conference section studying the nature of science and of faith, observing that "the universe of science is unimaginably vast, mysterious, and untouchable . . . overwhelming and dwarfing man into total insignificance," concluded:

"Science has arrived at mysteries which can only be dealt with, if at all, by theologians. At the same time, Christian theology is confronted with basic challenges to its traditional formulations. . . . Every creation emerges within a complex fabric of interdependency with all other elements of the created order.

"Traditional doctrines of the omnipotence of God must be rethought and reformulated. . . . But in the midst of this intellectual ferment in both science and theology, one senses the prospect of a new and more comprehensive vision of reality, . . . a vision of a wider truth and coherence which lies within our reach . . ."

Summarizing her experience at the conference, Jessica Crist, Protestant chaplain at M.I.T., admitted that the sessions caused considerable "turmoil." But "great things have happened," she said.

Will it all really make any difference? Professor Alves, who has attended World Council of Churches meetings for at least 20 years, told James L. Franklin of the Boston *Globe* that he always sees "great anxiety" among participants as they try to work out precisely the wording they want in documents and resolutions, "often under the delusion that they are making history.

"If that were so, all creation would have been recreated by the World Council more than 100 times," Dr. Alves told his audience. "This conference is, first of all, an educational experience; and that is more important than any final document." — *J.M.*

Sea Grant and the Maritime Academy

Help from the M.I.T. Sea Grant Program to the Massachusetts Maritime Academy at Bourne, Mass., has borne fruit in the form of a permanent collaboration in continuing education.

It all started in 1976 when the Sea Grant Program helped Massachusetts Maritime College develop a new elective curriculum. Now there are "extension" courses in diesel engines, hydraulics, navigation, seamanship, net mending, and first aid. And under a new state law making Massachusetts Maritime responsible for such an extension program, further collaboration is assured. "The response has been tremendous," said Thomas O'Neill, Lieutenant Governor of Massachusetts, at a summer ceremony, ". . . we commend M.I.T. Sea Grant for its continued support."

Professor Susskind's Goal for Planners: Know That You Have the Know-How

When he founded M.I.T., geologist William Barton Rogers set the Institute on its course of emphasizing pragmatism — "the importance of useful knowledge," he preached. Even today, 120 years later, the same trait distinguishes the Institute — even in such an area as city and regional planning, a profession essentially unknown when M.I.T. was founded. Here are excerpts from "Cries and Whispers," comments by Professor Lawrence E. Susskind, Ph.D. '73, head of the Department of Urban Studies and Planning, in its newsletter late last spring:

The Department of Urban Studies and Planning has a strong leaning toward the understanding and manipulation of institutions. While the public policy programs around the country train analysts who are especially interested in determining what the "best" policy is, we are interested in training planners and public managers who will be primarily concerned about implementing a "better program" or an "improved approach to coping with a problem," as defined by one or another client group. I think we would rather have our students spend most of their time developing their intuitive capacities for action-taking and working with clients than polishing the most sophisticated kinds of analytic skills.

I think we want our graduates to be implementation specialists — people who can size up a situation, help clients and colleagues work toward a shared sense of the problem, invent a change in program or policy and implement that change by working (very self-consciously) within the intricate inter-organizational web that characterizes the public sector.

If I had to pick one quality, above all others, that I would like to see our graduates leave with, it would be a sense of self-confidence — confidence in their ability to come out on top no matter how complicated and knotted a situation may be. That kind of self-confidence grows out of a faith in one's intuition. It also depends in part on having a set of tools in one's toolbag: analytic skills, organizational skills, conceptual skills, writing skills, presentation skills, group work skills, etc. I don't think a student needs to be the world's leading authority on any one of these techniques; in fact, it probably isn't even necessary to be right up with the state-of-the-art. The most important thing is to know what tools and techniques are available, and when they might be used.

Another source of self-confidence is specialized knowledge. To the extent that a student can develop an acquaintance with the latest jargon, acronyms, or governmental alphabet soup, it helps to boost self-confidence. Knowing that I have read some of the more recent writings, heard some of the most important speakers, discussed some of the more interesting theories, and tied into the most important networks is important to building my sense of professional self-confidence. It doesn't matter that most professionals will switch specializations half a dozen times or more during their career. Having become a specialist in one area, it is easier to go through the process a second time. It's knowing that you have the know-how that's most important.

Grace Professorship in Chemistry Honors Haslam and Dewey

W. R. Grace and Co., through the Grace Foundation, Inc., has endowed a professorship in chemistry in honor of the late Robert T. Haslam, '11, and the late Bradley Dewey, '09, who were key figures in developing the company as a leading factor in the chemical industry.

Both were distinguished chemical engineers, and they provided what J. Peter Grace, president and chief executive officer of the company, describes as "the essential leadership" for moving it into "a major position" in the industry.

Mr. Haslam taught chemical engineering for over a decade at M.I.T., then went with Standard Oil of New Jersey for 25 years, and finally joined the board of directors of Grace in 1950. It was then that he provided the company with "important advice on how to establish a position in the industry; and he had a powerful impact on the company's direction." Meanwhile, Mr. Dewey was developing the Dewey and Almy Chemical Co. on the basis of a number of inventions in food packaging materials; and when he retired as the company's president it was acquired by Grace. As a result, Messrs. Dewey and Haslam found themselves together on Grace's board of directors.

In making the grant to M.I.T., Mr. Grace called attention to the long-time service of both Messrs. Haslam and Dewey to the Institute; the new grant will assure a continuing relationship between the company and M.I.T.

Awards for a Book of Mathematics

The M.I.T. Press has won plaudits from mathematicians since its publication last year of an English-language edition of *The Encyclopedic Dictionary of Mathematics* edited by Shokichi Iyanaga and Yukiyosi Kawada: now the Press has received the Technical, Scientific, and Medical and R. R. Hawkins Awards of the Association of American Publishers for outstanding production of this complex volume.

Earthquakes: What You Need You Haven't Got

A curious perversity exists in man's relationship with his environment, says Hayrettin Kardestuncer, S.M. '57, Associate Professor of Civil Engineering at the University of Connecticut.

The structural materials most useful for earthquake-resistant buildings are selectively absent from populated earthquake zones where they are most needed.

The best material is wood, because it is flexible and resilient. But in countless parts of the world where people live on earthquake-prone fault lines — southern California, Italy, Turkey and the Middle East — wood is scarce and most structures are squat, rigid, and solid, built of materials like mud, brick, stone, and concrete.

Dr. Kardestuncer based his observations — which are part of a paper prepared for the International Association of Housing Sciences' conference on disaster planning in Istanbul last winter — on personal tours of many of the world's earthquake zones, where he studied housing, disaster damage, and the strategies used for recovery and relief. The latter, he says, are usually wrong: left to their own devices, people tend to rebuild in the image of what has been destroyed. Help from advanced countries to developing ones tends to provide "hard"-technology materials which are unfamiliar — and therefore useless — to local "soft"-technology builders.

What's needed, Dr. Kardestuncer told the conference, is a marriage of the two: an "alternate" technology suitable for local labor but incorporating more sophisticated, resilient, earthquake-proof materials.

An Architectural Editor Pleas for Design

The key question for his profession, says John M. Dixon, B. Arch. '55, Editor of *Progressive Architecture,* is this: what — and how — can architectural design contribute to the world to come?

Everyone recognizes that architecture is a service profession, meeting human needs by planning and managing the creation of buildings and systems. But many engineers serve in exactly this way, too; the quality that distinguishes architects, says Mr. Dixon, should be *design.*

Mr. Dixon identifies five possible responses of architects to this challenge:

☐ Continue in the profession's present course, assuming that "the public can learn to like isolated, closed forms with structural expression and minimal detailing."

☐ Try to re-establish the virtues of "unity of purpose and social consciousness," returning to the roots of modern architecture "in the manner of historical revivals."

☐ Return to the vernacular or to history, seeking and adapting forms and devices "that seemed to have worked" in the past.

☐ Turn to the behavioral sciences to learn "how people respond to built form and space," and then translate this learning into design — or at least use it as "an adjunct to intuitive design."

☐ Embrace analytical techniques from the sciences and use them "to synthesize designs . . . [and to] experiment with form, space, and color, etc. . . ."

For study in his magazine, Mr. Dixon opts for work that succeeds in "solving serious functional problems within real-world constraints" and — especially — for work that "breaks radically with convention. . . . If architectural design is not now serving the public to the fullest," writes Mr. Dixon, "then design exploration is, in fact, very much in the public interest."

New Needs for Computers in a Solar-Heated World

A self-contained solar system is now providing up to 75 per cent of the heat needed by the ten-unit Hizashi condominium in Palo Alto, Calif. — the first such self-contained system in the state, thinks Cuthbert C. Hurd, who studied in the Program for Senior Executives at the Sloan School in 1959.

Heat for condominium space and domestic hot water is provided by solar collectors with water as the medium for storage and distribution. Electricity to power pumps circulating the water is generated by photovoltaic cells producing slightly over 1 kilowatt of power.

Mr. Hurd — he's Chairman of Hurd Medearis Associates of Portola Valley, Calif. — is interested in the system because of its implications for the field of computers, in which he is a consultant, he told Marion Softky of the *Country Almanac* (Woodside, Calif.). "It is clear that computer systems in the future will play a more and more important part not only in energy conservation but in energy production and management," he said. "As projects are larger and use more supplemental forms of energy, they need more control — which implies computers."

A $1 Million Challenge in Health Sciences, Technology, and Management

A challenge grant of $1 million has been promised by the Kresge Foundation to support construction of the new facilities for the new College of Health Sciences, Technology, and Management. It would be paid on January, 1981, contingent on M.I.T. having by then obtained the balance of funds needed for the new building.

Howard W. Johnson, Chairman of the Corporation, is enthusiastic about the grant and its timing — "a critical time when we prepare to seek the additional commitments needed for this important project."

Architect Turned Quiltmaker: Opting Out of Compromise and Frustration

"You graduated from M.I.T.?"
"Yes; in architecture."
"What do you do now?"
"I help my wife make quilts."

That conversation with Jeffrey D. Gutcheon, '66, is apocryphal and fictitious — but not very.

For Beth and Jeffrey Gutcheon are quiltmakers, authors of *The Perfect Patchwork Primer* and now *The Quilt Design Workbook* (New York: Rawson Associates Publishers, Inc., 1976, $12.95). Their first book was described by the New York *Times* as "a Bible for those interested in this craft," and their second one by its publisher as "a workbook that takes the guess-work out of patchwork." Their books have brought the Gutcheons national fame; they are "among the best-known of contemporary American quilt-makers," says the publisher's "pitch" for their new book, and their quilts have appeared in many exhibitions in the U.S. and abroad.

How did it happen?

Mrs. Gutcheon explains in the foreword to their new book. Jeffrey "loved design — doing it, teaching it, and talking about it," she writes. But after several years in architectural offices he realized that "the realities of working as an architect had very little to do with designing and a great deal to do with compromise, frustration, and almost unendurable delay . . ." So he determined to become self-employed, as pianist and designer.

Meanwhile, Mrs. Gutcheon had a "primitive urge to make things," and presently she found that quiltmaking "meant more to me than any other craft. . . . I came to feel that American quilts are not just a series of artifacts but an important part of the history of American women. That their beauty, their ingenuity, and also the vast amount of repetition . . . in some important way constitutes a record of what life has been like for American women."

Mr. Gutcheon's interest in quilts followed when "he realized that designing a quilt was not unlike other kinds of design he had been trained for, and making a quilt was not unlike building a chair," Mrs. Gutcheon writes. As the accompanying diagram shows, and as the Gutcheons' books make vastly clearer, quiltmaking offers plenty of rather unique opportunities for designers. — *J.M.*

Piledriver in the West Campus: Indoor Rink, Field House Started

A small West Campus parking lot and the obsolescent outdoor skating rink on which countless students have learned to skate and countless of their more expert colleagues have defended their honor in hockey have been sacrificed to progress: ground has been broken and construction begun on a new indoor skating rink/athletic facility west of Rockwell Cage.

The new building, called an "athletics facility and special events center" in the literature, was a major Leadership Campaign goal, originally estimated at $6.2 million (including a 10-year maintenance fund). With inflation, that figure has advanced to nearly $8 million.

The indoor ice rink, on the lower level, will be the first in the Institute's history; there will be bleacher seating for about 1,500. Above it, a complete indoor field house — 200-meter running track and floor convertible between track events, basketball, baseball, softball, lacross, tennis, and rugby. Team locker rooms are included, and the lower (skating rink) level is to be convertible into a 4,500-seat special events auditorium.

Architectus are Davis Brody and Associates of New York, and completion is set by the contractor for the fall or early winter of 1980.

Mixing Electronics and Wine

To the Editor:
The suspense is killing. How *did* Paul Blelloch *(June/July, p. A32)* make out with his final examination in introductory electronics?
W. Kelly Woods, Sc.D. '40
Salem, Ore.

The details of academic records are confidential, so we'll never know. It was a pass/fail course, and Mr. Blelloch passed. – Ed.

Toward Appropriate Technology

Four M.I.T. alumni are in the news with alternative energy systems for heating and cooling in New England:

☐ **Eric M. Wormser,** '42, president of Wormser Scientific Corp. of Stamford, Conn., has completed a ground-water cooling system (in lieu of traditional air conditioning) in the Colonial Funeral Home, New Milford, Conn.

☐ **Charles G. Wing,** Ph.D. '66, who is in the Physics Department at Bowdoin College, now runs (with his wife Susan Black Wing) the Cornerstone School in Brunswick, Me., teaching how to build new homes and retrofit older homes for increased energy efficiency.

☐ **John Meyer,** M.Arch. '77, and **George T. Tremblay,** '75, who joined forces with other young architects from Harvard, Minnesota, Princeton, and the University of California, have completed a multi-level solar house which is now on the market in Stockbridge, Mass.

The Stockbridge house is an extension of ideas developed by Messrs. Meyer and Tremblay in their M.I.T. master's theses — a massive central core of concrete and brick surrounded by solariums, porches, and a greenhouse. The solariums and greenhouse are passive solar collectors, and the massive core serves as a heat storage unit; the system should contribute more than 50 per cent of the structure's winter heating requirements.

Mr. Wormser's air-conditioning system circulates cool ground water through heat-exchanger coils in the building's ventilating system; the air is cooled, and the (slightly) warmed ground water is returned to the aquifier from which it came. The same heat exchanger system could also distribute heat from solar collectors which may be added in the future. "As oil prices increase, you get close to making a good investment," Robert Hull, president of the Colonial Funeral Home, explained to Linda Martelli of the Danbury, Conn., *News-Times.*

Professor Wing began his professional career as a physicist for N.A.S.A., but after a while he became disillusioned with the $10-million project to which he was assigned. "I don't reject technology," he says. "I just think we have to develop technology appropriate to our real needs." The seed of his Cornerstone School was planted in a Bowdoin seminar on energy-efficient building.

Remember Building 20?

Whatever happened to Building 20, the World-War-II "temporary" building built for the Radiation Laboratory in 1942? Nothing: it's still there — the birthplace of many an interdepartmental and special activity and still the home for many.

The history and contributions of Building 20 — its informality lends a special quality to many tenants — will be the subject of an exhibition in the Margaret Hutchinson Gallery (Building 10 — the Alumni Center) in the spring, and the committee in charge wants photographs, mementos, and anecdotes. Write or call Virginia Gunter, Room 7-145, telephone (617) 253-5014.

Computer Excellence to Financial Aid

Donald Eastlake of Computer Corp. of America won the $150 Award for Excellence of the Institute for Certification of Computer Professionals this summer. Even before the ink on his check was dry, he'd called Weston Burner, director of M.I.T. Information Processing Services, off the floor of the annual meeting of the Association for Computing Machinery where the prize was given. Would M.I.T., where so many computer experts made their start, take his $150 as a contribution to scholarship funds? Yes, said Mr. Burner; and he did, in behalf of Jack H. Frailey, '44, director of student financial aid.

Getting Classes Off the Ground

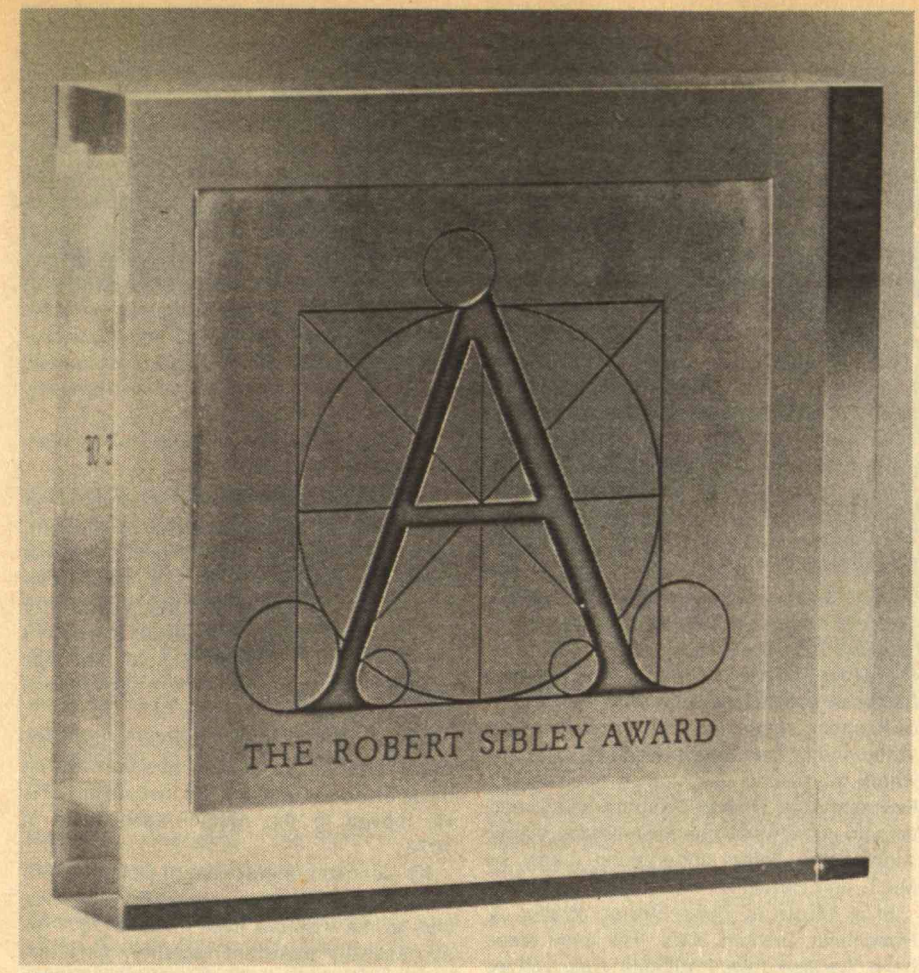
When an M.I.T. undergraduate class wants to start something, it starts from nothing: no treasury, no experience. Now the Alumni Association will help with the first of those problems, offering loans of up to $500 repayable in December of any class's junior year. In addition, there's a $400 reserve fund for classes that need short-term capital — especially if they need it to float fund-raising projects.

Nuclear Engineer Turned Shuttle Pilot

Frederick H. ("Rick") Hauck, S.M. '66, has "finally made it," he says — not as a nuclear engineer (the field he studied at M.I.T.) but as a pilot.

He's one of 35 candidates selected by N.A.S.A. to be the basic pilot cadre for the first fleet of five space shuttles.

Before coming to this job, Mr. Hauck — he



This plaque, which was accompanied by a $500 honorarium provided by Newsweek *magazine, signifies* Technology Review's *status as 1979 "magazine of the year" in the annual competition managed by the Council for the Advancement and Support of Education.*

holds the rank of commander in the Navy — did almost everything else in naval aviation. He applied to be an astronaut while at the Navy's postgraduate school in Monterrey in 1964. Only when his application was unsuccessful did he decide to come to M.I.T. for his master's in nuclear engineering. But flying turned out to be his "true love," says Commander Hauck, and by 1968 he had his Navy wings.

"Ever since then I've been motivated towards doing the next logical progression in the challenges of aviation," he told Howard Benedict of Associated Press this summer. So he became a test pilot and finally the next step — the shuttle. With N.A.S.A. projecting 50 shuttle flights a year by the mid-1980s, thinks Mr. Benedict, Commander Hauck and his colleagues among the new astronauts should get plenty of flight time.

Thurow: Turning to a Mass Audience at the Times

Lester C. Thurow, professor of economics, has embarked, at least temporarily, on a new career which will bring his ideas — some of which are considered radical by American business if not by the economics community of which Professor Thurow is an outspoken member — to a more massive audience than he's ever enjoyed before.

On sabbatical leave this year, Professor Thurow has an office on the tenth floor of the New York *Times* building, where he's sitting for the year as an economics expert on the *Times'* editorial board.

"I have no intention of leaving M.I.T.," Professor Thurow told David Warsh of the Boston *Globe*. "But I'd have been a fool to turn down an opportunity like this, if only to learn more about how the paper operates," he said. "Besides, if you are interested in affecting economic policy, as I am, this is one of the ways you can do it." It's apparently the first time an established, academic economist has been employed in an editorial capacity by a major paper, says Mr. Warsh.

Professor Thurow has just finished another effort to reach what he calls a "mass audience" — a book to be published next spring by Basic Books. The *Zero-Sum Society* addresses in popular terms "the standard inventory of modern problems," says Mr. Warsh, "beginning with inflation and including poverty and unemployment, and it poses alternative solutions to each, toting up costs and benefits of each approach."

"All our problems have solutions," Professor Thurow told Mr. Warsh — though he admits that not all are politically feasible. "Whether they are planning-oriented or market-oriented," Professor Thurow said, "these solutions have the common denominator that the government must be willing to impose large economic penalties on one group or another."

The Sibley Magazine of the Year

Many U.S. colleges and universities serve their graduates and other constituencies by publishing magazines, the best of which are very good. But in 1978–79, say the judges appointed by the Council for the Advancement and Support of Education, *Technology Review* was the best of all. Accordingly, we're in possession of the Council's Robert Sibley Award for 1979.

Mr. Sibley's first career was in engineering, and he rose to become dean of the School of Engineering at the University of Montana; then, for 27 years prior to retirement in 1949, his warm affection for people and his *alma mater* came to the fore while he led the University of California's alumni association. It was under his aegis that the idea of university magazines began to flower. Since then many of the nation's most able editors have left their marks on the genre, the institutions they serve, and their editorial colleagues. This editor has learned much from many over the years — a substantial debt which makes the coming of the Sibley to *Technology Review* (for the second time in our history) a very special event.

Volume 81, which closed last month, was good for *Technology Review* in other ways, too. Our advertising volume was sharply up. We've had the benefit of a thorough review by a blue-ribbon committee representing the ultimate authority we serve — the Board of Directors of the Alumni Association. And the number of our subscribers is larger now than ever before in history.

A word of thanks, then, from the Editor to all whose efforts helped us become the 1979 "magazine of the year" — and in turn from all of us to all whose response gave volume 81 the best performance of any we've published. — *J.M.*

Professors Cartwright and Maier Become Acting Leaders of Humanities

Professors Richard L. Cartwright and Pauline R. Maier have been named acting head and acting assocaite head, respectively, of the Department of Humanities. They'll fill the assignments vacated by Professor Bruce Mazlish, who resigned as head effective last July; he'll return to full-time teaching after a leave of absence for research during the current academic year.

Professor Cartwright was head of the Department of Philosophy from 1971 until the formation of the Department of Linguistics

R. S. Stone

R. D. Blake

P. E. Johnson

J. Sclar

and Philosophy in 1976; Professor Maier came to M.I.T. a year ago to teach in the field of American political history.

Dean William L. Porter Will Retire

Professor William L. Porter, Ph.D. '69, who has been dean of the School of Architecture of Planning since 1971, will leave that post at the end of the current academic year. He wants to resume teaching in the school's Environmental Design Program and to participate in the Aga Khan Program for Islamic Architecture being undertaking jointly by M.I.T. and Harvard.

In a tribute to Dean Porter, Walter A. Rosenblith, provost, said "His fresh ideas have changed many traditional perspectives of the school. Dean Porter has earned great respect for his development and articulation . . . of [teaching and research on] important environmental and social problems."

Professor Rosenblith's office will lead a nationwide search for Dean Porter's successor, with the assistance of an advisory committee from the school.

Four Changes in the Alumni Association

Four new appointments in the staff of the Alumni Association:

☐ **Ronald S. Stone,** '59, formerly regional director for the west, is now in a new position, director of operations.

☐ **Robert D. Blake,** formerly regional director for New England, is assuming Mr. Stone's previous assignment as regional director for the west.

☐ **Paul E. Johnson,** formerly manager of international programs at G.T.E./Sylvania, Waltham, Mass., is now regional director for New England.

☐ **Joan Sclar,** since 1977 administrative assistant to the director of the Alumni Fund, is now regional director for the southeast.

As director of operations, Mr. Stone will supervise all regional programs and will serve as deputy to James A. Hester, '65, executive vice president, in administering the staff of the association as a whole — an effort to strengthen the overall management structure of the association, says Mr. Hester.

Mr. Stone, who studied chemistry at M.I.T. and later at the University of Vermont, (M.S. 1961) and the University of California (Berkeley), returned to M.I.T. in 1966 as industrial liaison officer and four years later became assistant dean and executive officer of the Graduate School. He was named associate director of the Alumni Fund in 1974.

A graduate of Dartmouth (A.B. 1965), Mr. Blake was named special assistant in the office of the secretary of the Insitute in 1970. He moved to the Alumni Association in 1976.

Mr. Johnson, a graduate of Colgate (A.B. 1960) and Boston University (Ed.M. 1968), was at the Institute from 1962 to 1974 as successively assistant registrar, assistant director of admissions, assistant to the vice president and secretary, and director of Institute Information Services. Since then he's been associated with Mead Corp., the Education Development Center (field project administrator in Algeria) and — since 1978 — Sylvania Technical Systems International, Inc.

Ms. Sclar's work since 1977 has involved central support for Alumni Fund activities and (in 1978–79) management of the Fund's extensive telethon programs. She studied at the State University of New York at Buffalo (B.Ed. 1969) and Boston University (Ed.M. 1970) and taught in Boston and Newton schools before coming to the Institute in 1974. In her new duties in the southeast, Ms. Sclar succeeds Martha S. Draper, who left M.I.T. to be married and join her husband in Washington, D.C., in June.

Individuals Noteworthy

Changes at M.I.T.

Alice Seelinger, a long-time member of the Dean's Office, is to be on leave for 1979–80 and tells *The Tech* that she is likely to seek some other assignment at M.I.T. thereafter. "After seven years in the Dean's Office, it's time to go on to something else," she says. . . . **Florence C. Ladd,** formerly associate dean of the School of Architecture and Planning, has left M.I.T. to become dean of students at Wellesley. . . . Two new ap-

pointments in the Medical Department: Dr. **Fruma W. Ginsburgh,** obstetrician and gynecologist, and Dr. **Cynthia M. Stevens-Onyejekwe,** chief of the Dental Health Service. . . . **Isaac M. Colbert,** senior consultant to the Office of Personnel Development since 1977, is now the Institute's assistant equal opportunity officer. . . . **Kenneth J. Cerino** has arrived in Cambridge from Iowa State University to become director of sports information; he succeeds **Jill Gilpatric,** who's joined Professor jane Betts in the women's athletic program.

Honors and Awards

Robert V. Dodd, associate comptroller at Lincoln Laboratory, to vice president of the National Association of Accountants . . . sculptures by **Jeffrey Schiff,** assistant manager of the Hayden Gallery, at the Intitute of Contemporary Art, Boston, during the summer . . . to **Preston Vorlicek,** '79, an N.C.A.A. graduate scholarship for further study at M.I.T. . . . to **Stephen J. Cucchiaro,** '74, a gold medal in sailing (International 470s) at the Pan American Games, San Juan.

Rising and Changing in the World of Business

Ron Dagani, Ph.D. '75, on the editorial staff of the Raleigh *News and Observer* for ten weeks last summer as a 1979 mass media science fellow of the American Association for the Advancement of Science . . . **Thomas H. Farquhar,** '60, to senior vice president of Massachusetts Financial Services Co. . . . **Robert W. Baker,** '59, to vice president — freight marketing, American Airlines . . . **Robert H. Brown, Jr.,** '54, to president and chief operating officer of Belding Heminway Co., Inc., New York, succeeding **Richard T. Kropf,** '31, who has retired . . . Two changes at Mead Corp., Dayton, Ohio: **Steven C. Mason,** '57, to group vice president — paperboard and **Michael Allik,** '57, to senior vice president, where he will be the company's chief strategy officer . . . **Carl R. Meurk,** to vice president of Todd Shipyards Corp. . . . **Michael S. Adler,** '65, to manager of the Device Physics Unit, Power Semiconductor Branch, General Electric Research and Development Center . . . **George T. Eldis,** '60, to manager of ferrous metallurgy, Climax Molybdenum Co. research laboratory, Ann Arbor, Mich. . . . **Norton Belknap,** '50, to senior vice president of Exxon International . . . **Frank Heart,** '51, to senior vice president of Bolt, Baranek and Newman, Inc., Cambridge.

To corporate boards of directors: **John E. Preschlack,** '54, president of General Binding Corp., to House of Vision, Inc., Chicago . . . **Curtis D. Buford,** '42, president of Trailer Train Co., to Alleghany Corp.

Dr. **Joseph A. Horton,** '69, is associate professor of radiology in the School of Medicine, West Virginia University.

George R. Harrison, who died on July 27, was dean of the School of Science for 22 years. His work of the 1930s developing and recording spectral data was a major scientific tour de force, and he continued work in spectroscopy while bringing the School of Science to "new standards of excellence and achievement" as its dean.

George R. Harrison, 1898–1979: A Giant of 20th Century Physics

George R. Harrison, who was dean of the School of Science for 22 years from 1942 to 1964 after serving on the Physics Department faculty for 12 years starting in 1930, died in Concord, Mass., on July 27 following a long illness. He was 81.

As dean, Professor Harrison "set the standards of excellence and achievement that have made science teaching and research at M.I.T. pre-eminent throughout the world," said President Jerome B. Wiesner. "Those of us who were inspired by him will always remember that he drew the authority for his leadership simply from his own example.

"He combined a towering intellect, a facile and inventive turn of mind, a passion for extraordinary precision, inexhaustible patience, an orderly and careful nature, and a sophisticated sense of humor."

Two former presidents of the Institute whom Dean Harrison served added their own tributes:

☐ James R. Killian, Jr., '26: "I depended upon him greatly for his wisdom, judgment, and loyalty to the highest ideals of the Institute. [George Harrison] was a man of immense charm, an eloquent, witty speaker, and a brilliant interpreter of science. We who had the privilege of being his colleagues and friends will always remember with affection and admiration the delights and enrichment of our associations with him."

☐ Julius A. Stratton, '23: "His encouragement and support of science for its own sake and as a partner of engineering were basic to fundamental changes in the character of this institution. For his wisdom, for his deep concern for M.I.T. as a whole, for his distinguished record of scientific accomplishments and public service, and especially for his generous concern for others and the warmth of his friendship, George Harrison will long be remembered.

A native of San Diego, Dean Harrison studied physics at Stanford, where he taught before coming to Harvard en route to M.I.T. As founder and director of the M.I.T. Spectroscopy Laboratory, he developed wavelength tables showing the spectra of the optical emission lines for virtually every atom — tables that still stand today as references for spectrographic studies in all branches of science. Bringing technology to physics, he built and used new ruling engines to make diffraction gratings of unprecedented fineness and precision.

"It is not possible to overdramatize the importance of optical spectroscopy to modern science," Dr. Wiesner said, "and it is not possible to overstate Dean Harrison's contributions to the development of this ubiquitous and fundamental scientific tool."

During World War II Dean Harrison served as chief of the Optics Division of the National Defense Research Committee, developing military devices of many kinds — including infrared instruments to permit accurate night-time military operations; he also served briefly with General Douglas MacArthur in the southwest Pacific.

Dean Harison wrote effectively about physical science for many different audiences; his *Practical Spectroscopy* was widely used as a college text, while *Atoms in Action* was a highly successful popular account of physical science. In addition, there were more than 100 professional papers and countless major awards in the field of physics.

Gilbert W. Low, 1939–1979

Gilbert W. Low, Ph.D. '67, assistant professor of management in the Sloan School, died on July 15 in an automobile accident while in a remote area of the Michoacan region of Mexico. He was 40.

Before coming to M.I.T. for graduate study toward his doctorate, Professor Low had served with Morgan Guaranty Trust Co. from 1963 to 1971 in New York and Paris, rising to the rank of vice president. Earlier he had graduated in political science from Dartmouth (B.A. 1961) and in politics, philosophy, and economics from Magdalen College, Oxford (Honours B.A. 1963), where he was a Rhodes Scholar.

His M.I.T. degree was in the field of system dynamics, and upon receiving it he promptly joined the faculty to work with Professor Jay W. Forrester, S.M. '45, in evaluations of economic policy using the system dynamics national model. Professor Forrester described him as "a gifted teacher

especially active in developing educational programs" in the field, "a friendly outreaching personality that attracted students and that drew him into a key role with research sponsors. The world-wide field of system dynamics has lost one of its most able members."

In addition to his work at M.I.T., Professor Low had taught at Northeastern, Dartmouth, the Harvard Extension Program, and the Harvard Summer School.

Robert B. Woodward, 1917–1979

Robert B. Woodward, '36, Donnor Professor of Chemistry at Harvard who was a member of the M.I.T. Corporation from 1966 to 1971, died suddenly of a heart attack at his home in Cambridge on July 8. He was 62.

At the time he received his doctorate from M.I.T. in 1939, Professor Woodward was the youngest person ever to hold that Institute degree. He immediately joined Harvard, where he began the work which would earn him world regard as the greatest synthetic organic chemist of modern times. His work as chemical architect led to commercial mass production of many life-saving drugs, including quinine, to the Nobel Prize in chemistry (1965), and to other major awards and honorary degrees.

Recognizing Professor Woodward's unusual achievements as a graduate student, many of his M.I.T. professors hailed him as "first in a class of one." But he nearly flunked out: for twice failing economics and for refusing to complete the physical education requirement.

A. Rufus Applegarth, 1913–1979

A. Rufus Applegarth, '35, vice president and co-founder of National Aeronautical Corp., died on May 10 while on a business trip in the Washington, D.C., area. He was 66.

Mr. Applegarth, whose home and business were in the Philadelphia area, was a loyal supporter of M.I.T., active in eastern Pennsylavnia and on numerous national boards and committees; he was a member of the Alumni Association Board of Directors from 1968 to 1970 and vice president of the Association in 1971–72.

Charles H. Stevens, 1925–1979

Charles H. Stevens, executive director of the Southeastern Library Network, Atlanta, died on April 1 at the age of 54.

Mr. Stevens was director of library and publications at Lincoln Laboratory from 1959 to 1965 and then for seven years was associate director of Project Intrex, a study of computer-based library services on the Cambridge campus.

Deceased

Kirk W. Dyer, '07; June 28, 1979; c/o Eckersley, Brault Hill Rd., Higganum, Conn.
C. William Wallour, '10; March 7, 1979; 10 Bay State Rd., Wellesley, Mass
Louis F. Quirk, '15; September 19, 1978; Box 284, Middletown, Conn.
Harry B. Smith, '16; June 21, 1979; 210A Huntington Dr., Lakewood, N.J.
George Abbot, '17; March 31, 1979; 3260 Gray St., Denver, Colo.
Dr. John L. Parsons, '17; May 18, 1979; 18 Rolling Ln., Dover, Mass.
John B. Mattson, '21; July 19, 1979; 69 Sargent St., Winthrop, Mass.
Bartow van Ness, Jr., '22; October 2, 1978; 205 Churchwardens Rd., Baltimore, Md.
George A. Shattuck, '22; July 5, 1979; 2535 Cardwell Way, Sarasota, Fla.
Horacio Garcia Capurro, '26; December, 1978
Joseph S. Harris, '27; July 19, 1979; Box 654, Masons Island, Mystic, Conn.
Col. Anthony Fleming, '28; May 20, 1979; 6860 Memphis St., New Orleans, La.
J. Conrad Sacco, '28; December, 1978
Leonard Stievater, Jr., '29; August 31, 1977; 636 Yupon St., New Smyrna Beach, Fla.
William C. Whiting, '29; July 4, 1979; P.O. Box 144, Hanover, Mass.
Robert D. McCarron, '30; July 19, 1979; 30 Waban Hill Rd., Chestnut Hill, Mass.
Charles M. Twelves, Jr., '30; July 10, 1979; 360 N. Civic Dr., No. 311, Walnut Creek, Calif.
Harland A. Danforth, Jr., '31; February 1, 1979; 18101 Gillman St., Irvine, Calif.
Daniel P. Dyer, Jr., '32; June 18, 1979; 1374 Somerset, Grosse Pointe Pk., Mich.
Joseph L. H. Kemper, '35; April 20, 1979; P.O. Box 111B, 1st National Bank Trust, Cincinnati, Ohio
Dr. R. B. Woodward, '36; July 8, 1979; 1010 Memorial Drive, Cambridge, Mass.
Jean R. Portelance, '37; July 14, 1979; 98 de l'Eglise, St. Sauver, Quebec, Canada
Howard I. Schlansker, '38; June 20, 1979; 1389 Myron St., Schenectady, N.Y.
Capt. Leon P. Eisman, '40; January 8, 1977; 545 Stewart Ln., Mansfield, Ohio
Curtis H. Elliott, Jr., '45; January 24, 1979; 637 Plymouth Rd., Baltimore, Md.
Hugh R. Jackson, '46; April 19, 1979; 1612 Sunnycrest, Fullerton, Calif.
Victor Azgapetian, '47; November 9, 1978; 233 Amherst Rd., Costa Mesa, Calif.
Walter M. Davis, '49; April 10, 1979; 831 Fox Hills Dr., Sun City Center, Fla.
Dr. Allen Lurio, '50; August, 1978; 126 Judson Ave., Dobbs Ferry, N.Y.
Julius Leonhard, '51; June 24, 1979; 93 Acton St., Maynard, Mass.
Pedro E. Moran, '51; December, 1978
Richard C. Engelken, '55; May 4, 1976; 43 Garfield Ave., Clifton, N.J.
John R. Mann, '59; June 5, 1979; 5 Perham St., Bedford, Mass.
Jerome N. Caplan, '70; February 25, 1979; c/o Dr. Hyman Caplan, 373 Laurier Ave. East, Apt. 406, Ottawa, Ontario, Canada
Robert H. Mooney, Jr., '76; June 4, 1979; 4274 Sugar Maple Ln., Okemos, Mich.
Dr. Gilbert W. Low, 77; July 15, 1979; 34 Hamilton Dr., Arlington, Mass.
Dr. George R. Harrison; July 27, 1979; 170 Barnes Hill Rd., Concord, Mass.

Puzzle Corner
Allan J. Gottlieb

Allan Gottlieb is associate professor of mathematics and coordinator for computer mathematics at York College of the City University of New York; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y., 11451.

Smooth Rolling for a Square Wheel?

Let me begin by answering a perennial question. My method of selecting solutions to publish is as follows: As responses arrive during the month they are simply put together in neat piles with no regard as to their postmark or date of arrival. When it is time to write, I first weed out erroneous or illegible solutions. For difficult problems this may be enough. Usually, however, many responses still remain. I next try to select solutions that supply an appropriate amount of detail and that include a minimal number of characters that are hard to set in type. A particularly elegant solution is of course preferred. Of those selected, I favor contributions from respondents whose solutions have not previously appeared. Finally, especially neatly written or typed solutions are preferred, as this tends to reduce typographical errors.

Problems

OCT 1 We begin with a theoretical bridge problem by John Rutherford concerning the conditional probability of various card distributions. Mr. Rutherford writes what he calls "a serious question":
Suppose you and dummy have two seven-card fits (i.e., suits in which you are lacking six cards). The *a priori* odds for the division of six outstanding cards are well known at 48:36:15:1 for a 4-2:3-3:5-1:6-0 split. My question is, How do those odds change for the division of the second suit after you have played the first suit and established what the first split was? In particular, what are the odds for the division(s) of the second suit when the first suit is known to have split (a) 4-2 or (b) 3-3? I think they are quite different in these two cases, but before going on I would like to know what *you* think the probabilities are.

OCT 2 Our second problem, from R. Crandall, sounds like one Conrail has been working on. Mr. Crandall wants you to describe a track upon which a square wheel rolls smoothly without slipping.

OCT 3 Emmett Duffy likes to play with numbers. He would like you to find the smallest number N which can be partitioned into seven distinct positive integers such that the sums of any six of these integers is a perfect square. That is,

$$N = A_1 + A_2 + A_3 + A_4 + A_5 + A_6 + A_7$$

and the following seven numbers are all perfect squares:

$$\begin{aligned} & A_2 + A_3 + A_4 + A_5 + A_6 + A_6 \\ A_1 \quad & + A_3 + A_4 + A_5 + A_6 + A_7 \\ & \cdot \qquad \cdot \qquad \cdot \\ A_1 + A_2 + A_3 + A_4 + A_5 + A_6. & \end{aligned}$$

When you finish this try the sum of eight positive integers with the sum of any seven a square, then any eight out of nine, and finally any nine out of ten.

OCT 4 John Rule sends us one of his favorites which he attributes to J. Pennington. It first appeared in the *American Mathematical Monthly* a quarter century ago:
SMITH: Down in Todd Country, which is a 19-mile square, I have a ranch — rectangular, not square, in shape — measuring a whole number of miles each way.
JAMES: Hold on a minute. I happen to know the area of your ranch; let me see if I can figure out its dimensions. (He figures furiously.) I need more information. Is the width more than half the length?
Smith answered the question.
JAMES: Now I know the dimensions of your ranch.
BROWN: I, too, know the area and, although I did not hear your answer to James' question, I, too, can tell you the dimensions.
GREEN: I did not know the area of your ranch but, since I have heard this conversation, I can deduce it.
What are the dimensions of the ranch?

OCT 5 We close with a "best possible" cryptarithmetic problem from Frank Rubin: Replace each letter with a unique digit.

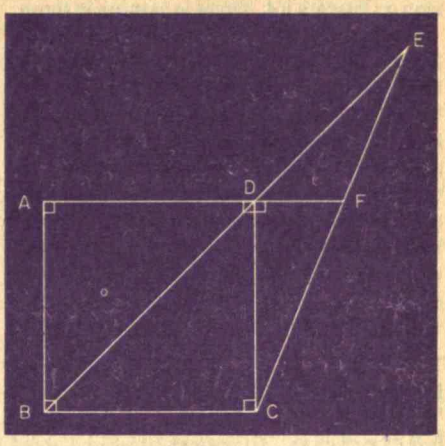
FOUND × A = SKILL

What is the value of SKILL? This is the *only* short multiplication in base 10 which has a unique solution and which involves as few as eleven digits in total. That is, this is the best possible problem, in the sense of least redundancy.

Speed Dept.

OCT SD1 Hugh Steward wants a common English word containing the sequence LIH.

OCT SD2 Scott Byron has a cute geometry problem:
ABCD is a square. D is on BE. AB = BC = CD = AD = DE = 3. Find DF.



Solutions

MAY 1 White has four pieces — king, queen, and both bishops — all in starting positions on the first rank. Black has a lone king on Black's K4. White is to mate in three.

The following solution is from Jacob Dolid and his friend Boris:

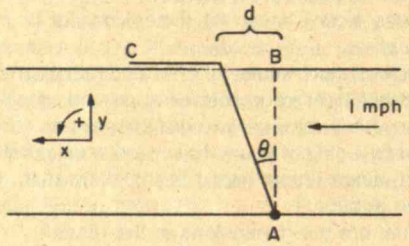
I thought you might be interested in learning how a solution was achieved. I am vacationing at my son-in-law's home and I have with me the electronic chess player, Boris. I introduced the positions specified and programmed Boris for a ten-minute interval and had him play the first move. He succeeded in making the key move of KB — B4. His move of Black's King to B3 permitted mate in three moves, as outlined below. This gave me the clue to the solutions for all possible moves.

	White	*Black*
1	KB — B4	K — B3
2	Q — Q6 ch	K — B4
3	Q — K6 mate;	
or		
2		K — N2
3	Q — R6 mate.	
If		
1		K — B4
2	Q — R5 ch	K — B3
3	Q — N5 mate;	
or		
2		K — K5
3	Q — Q5 mate.	
If		
1		K — K5
2	Q — Q5 mate.	

Also solved by George Colpitts, John Fine, J. Goldsmith, Glen Iba, Michael Jung, Ray Kinsley, Temple Patton, David Rabinowitz, Paul Reeves, Blaine Rhoades, Frank Rubin, Theodore Sauppe, Larry Shiller, Jerome Taylor, John Trifiletti, and the proposer, Elliot Roberts.

MAY 2 A swimmer, who swims at a constant rate of two miles per hour relative to the water, wants to reach point C on the other side of the river from point A, where he now is. He swims from point A to point B, across the river, and then walks from point B to point C. You are to find the optimum angle ABC — i.e., the angle for which the travel time is minimized — for a given walking speed (which is greater than the swimming speed).

Steven Mayberry solved this completely and also calculated a percentage improvement for four-minute milers. His response follows:



The swimmer's speed in the y direction, in miles per hour, is (2 cos θ), and the time (t_1) to cross the river, in hours, is 1/(2 cos θ). The speed of the swimmer in the x direction is (2 sin θ); then adding the current of the river, his total speed (in miles per hour) is (2 sin θ + 1). Thus the distance that the swimmer is moved downstream (in the x direction) is

$$d = t_1(2 \sin \theta + 1).$$

The distance left to walk is (1 − d) and time to travel it is

$$t_2 = |(1 - d)/w|,$$

where w is the walking speed. The absolute value is necessary for the cases where d is greater than 1 mile between points B and C. That is where the swimmer would arrive downstream of point C and have to walk back. The total time spent (t_T) is $t_1 + t_2$. Substituting for t_1 and t_2,

$$t_T = 1/(2 \cos \theta) + |(1 - d)|/w,$$

and substituting for d,

$$t_T = 1/(2 \cos \theta) + |[1 - (2 \sin \theta + 1)/2 \cos \theta]|/w.$$

The next step is to take the partial derivative with respect to θ. To simplify the derivative, the absolute value is dropped for now:

$$\frac{\alpha t_T}{\alpha \theta} = \frac{\sin \theta}{2 \cos^2 \theta} - \frac{(2 \sin \theta + 1)\dfrac{\sin \theta}{2 \cos^2 \theta} + \dfrac{2 \cos \theta}{2 \cos \theta}}{w}$$

$$= \frac{\tan \theta}{2 \cos \theta} - \frac{\tan^2 \theta + \dfrac{\tan \theta}{2 \cos \theta} + 1}{w}$$

Setting this partial equal to 0 then yields the minimum except in the case where (1 − d) < 0. When this is the case, the partial does not reach a minimum; however, t_2 is negative, an impossible situation. If t_2 is always positive, any point that the swimmer arrives downstream from point C yields a longer travel time than no walking at all.

So, d must remain less than 1, else the solution for minimum time becomes the simple solution which specifies that points A and B are opposite each other on the two sides of the river. Thus, the time is minimum when the following two equations are satisfied:

$$\frac{\tan \theta}{2 \cos \theta} - \frac{\tan^2 \theta + \tan \theta / 2 \cos \theta + 1}{w} = 0,$$

i.e., $\theta = \sin^{-1}(2/(w - 1))$,
when $(2 \sin \theta + 1)/2 \cos \theta \leq 1$ and
$\cos \theta - \sin \theta = \frac{1}{2}$,
when $(2 \sin \theta + 1)/2 \cos \theta > 1$.

It is interesting to note that:

1. The solution to $\cos \theta - \sin \theta = \frac{1}{2}$ is $\theta = -24.295°$, and t_T is then 32 minutes 55 seconds.
2. For walking to make any difference in time at all (in contrast to swimming directly from A to C), w > 5.86 miles per hour; otherwise the θ to minimize t_T all yield a distance downstream from point C and it is faster to swim direct; 5.86 miles per hour is pretty brisk to be called a walk — probably more in the class of jogging.
3. At w = 15 miles per hour (four-minute mile), $\theta = -8.21°$; t_T = 31 minutes 43 seconds, a saving of only 3.7 per cent. Few people can run this fast. Many more can swim at 2 miles an hour.

Also solved by Gerald Blum, Irving Hopkins, Raphael Justewicz, Ray Kinsley, James Landau, Victor Newton, John Prussing, Paul Reeves, Frank Rubin, Larry Shiller, John Trifilleti, Don Uhl, Frederick Vose, and Harry Zaremba.

MAY 3 Complete the following 3 × 3 magic square.

1	2	a
3	b	c
d	e	f

Many readers were able to solve this one. The trick is not to assume that the entries are integers. The following complete derivation is from Cushnie:

First row	(1) = 1 + 2 + a
Second row	(2) = 3 + b + c
Third row	(3) = d + e + f
First column	(4) = 1 + 3 + d
Second column	(5) = 2 + b + e
Third column	(6) = a + c + f
Diagonal l. to r.	(7) = 1 + b + f
Diagonal r. to l.	(8) = a + b + d

(1) = (4): $\cancel{1} + \cancel{2} + a = 1 + \cancel{3} + d$

$a = d + 1$

(2) = (5): $3 + \cancel{b} + c = 2 + \cancel{b} + e$

$\cancel{2} + 1 + c = \cancel{2} + e$

$e = c + 1$

(7) = (8): $1 + \cancel{b} + f = a + \cancel{b} + d$

$\cancel{1} + f = d + \cancel{1} + d$

$f = 2d$

(3) = (7): $d + e + \cancel{f} = 1 + b + \cancel{f}$

$d + c + \cancel{1} = \cancel{1} + b$

$b = d + c$

(1) = (2): $\cancel{1} + \cancel{2} + a = \cancel{3} + b + c$

$\cancel{d} + 1 = \cancel{d} + c + c$

$c = 0.5$

(1) = (3): $1 + 2 + a = d + e + f$

$3 + \cancel{d} + \cancel{1} = \cancel{d} + c + \cancel{1} + 2d$

$3 = 0.5 + 2d$

$d = 1.25$

$a = d + 1 = 2.25$
$b = d + c = 1.75$
$e = c + 1 = 1.5$
$f = 2d = 2.5$

1	2	2.25
3	1.75	0.5
1.25	1.5	2.5

The answer is shown at the bottom of the previous column, with all eight totalling 5.25.

Also solved by Richard Bator, A. Bigus, Gerald Blum, Nancy Burstein, Frank Carbin, George Colpitts, Jack Crawford, Walter Delashmit, Doug Delgatty, Reverend George Doskocil, Robert Elkus, John Fine, Gertrude Fox, Clarence Gregory, Michael Haney, Winslow Hartford, Harry Hazard, Deborah Hooper, Glenn Iba, Michael Jung, Raphael Justewicz, Ray Kinsley, Joe Kaskal, Glen Krc, James Landau, Stephen Laug, Mary Lindenberg, Judith Longyear, Larry Marden, Naomi Markowitz, Sam McCluney, Roger Milkman, Avi Ornstein, Ronald Ort, Bert Posthill, Paul Reeves, Frank Rubin, Dan Sheingold, Jerome Shipman, Norman Spencer, John Trifiletti, William Turner, Charles Wolf, Harry Zaremba, and the proposer, Peter Groot.

MAY 4 Find a continued fraction expansion for $\sqrt{x}$. That is a continued fraction written in terms of x that, for each positive x, converges to $\sqrt{x}$.

This problem is not easy. It does not suffice to give continued fractions for specific values of x. Of course using a term like $\sqrt{x+1}$ is forbidden. Judith Longyear (she now refers to me as Mr. Doctor Alice Gottlieb — presumably a take-off on the German "frau Doktor") submitted a derivation which she claims would be well known to "addicts of the Pell equation"; combining hers with the work of Paul Reeves and Glen Iba gives the following:

Let y be the desired continued fraction; then $y^2 = x$.

$$y^2 - 1 = x - 1$$

$$(y + 1)(y - 1) = x - 1$$

$$y - 1 = (x - 1)/(y + 1) \qquad (A)$$

$$y = 1 + \frac{1}{1/(x-1) + y/(x-1)}$$

$$y = 1 + \frac{1}{2/(x-1) + (y-1)/(x-1)}. \qquad (B)$$

But from (A) we have

$(y - 1)/(x - 1) = 1/(1 + y)$. Thus

$$y = 1 + \frac{1}{2/(x-1) + 1/(1+y)}, \text{ or}$$

$$y + 1 = 2 + \frac{x-1}{\dfrac{2 + x - 1}{y + 1}}$$

As a continued fraction this becomes:

$$\sqrt{x} = 1 + \cfrac{x-1}{2 + \cfrac{x-1}{2 + \cfrac{x-1}{2 + \cfrac{x-1}{2 + \cdots}}}}$$

But now the question is, For what values of x does the limit converge? That is, define

$$a_0 = 2$$

$$a_1 = 2 + \frac{x-1}{2}$$

$$a_2 = 2 + \cfrac{x-1}{2 + \cfrac{x-1}{2}}$$

$$a_{n+1} = 2 + \frac{x-1}{a_n}$$

Is it the case that for each $x > 0 \lim_{n\to\infty} a_n$ exists? If it exists, the Reeves-Iba argument shows that the limit is $\sqrt{x} + 1$ as desired. For $x = 1$ everything is trivial. Assume $x > 1$. Then, as noted by Neil Cohen,

$a_1 < a_3 < a_5 < \ldots$ and $a_2 > a_4 > a_6 > \ldots$. Also $a_{2n-1} < a_{2n}$.

Thus the odd a's are growing and are less than the even a's which are shrinking. So each subsequence has a limit. All that is needed is to show that $(a_{2n} - a_{2n-1})$ approaches 0. This does not appear to be trivial. James Landau notes that this holds for $x < 2$. In fact he considers the parameterized continued fractions

$$b + \cfrac{x - b^2}{b + \cfrac{x - b^2}{b + \ldots}}$$

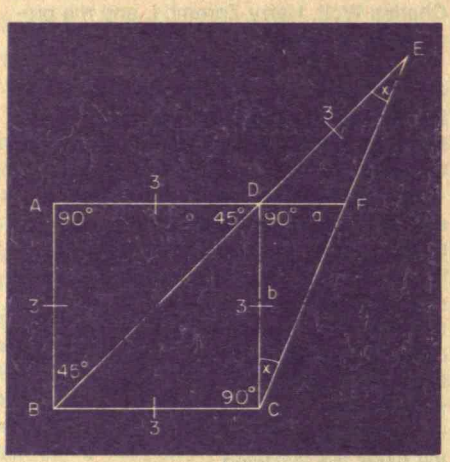
and concludes that this continued fraction approaches $\sqrt{x}$ for $b < x < 2b$. The Cohen analysis corresponds to $b = 1$. (A copy of Mr. Landau's analysis may be obtained from the editor. Mr. Landau also noted that other approximations to $\sqrt{x}$, in particular Newton's method, converge quicker.)

Responses were also received from Raphael Justewicz, Walter Penney, Frank Rubin, Norman Spencer, John Trifiletti, and the proposer, Ken Austin.

Better Late Than Never

1978 D/J 3 John Fine and Sidney Markowitz have responded.

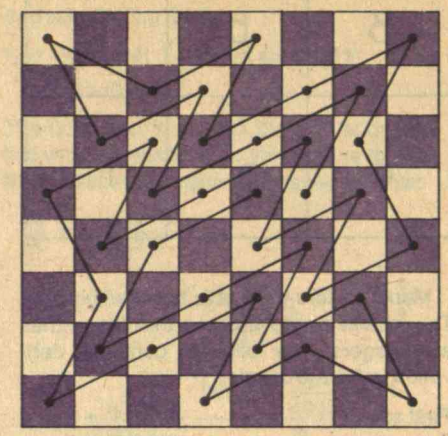
1979 FEB 1 Frank Rubin has found the following *uncrossed* Knight's tour consisting of 35 moves (36 squares) which he claims is optimal:



Proposers' Solutions to Speed Problems

OCT SD1 LIKELIHOOD.

OCT SD2 Most people don't see that angle DCF equals angle DEF and start constructing lines. This is unnecessary:



$135° + (2x)° = 180°$
$(2x)° = 45°$
$x = 22.5°$
$DF = a$
$b = DC = 3$
$\text{Tan } 22.5° = a/b = a/3$
$a = 3 \tan 22.5° = 1.242640687.$

My chairman, Joseph Malkevitch, happened to glance at this solution and immediately found a simpler method. He noted that $BD = 3\sqrt{2}$ and that, by similar triangles, $3/(3 + 3\sqrt{2}) = a/3$. Thus $a = 3(\sqrt{2} - 1)$.

able. On the resulting *Draisennes*, later called *velocipedes*, people began beating the times for similar journeys made by walking — the era of human-powered utility land transportation had arrived. Indeed, the speed of a lightweight British version was ten miles per hour — so fast that it was considered dangerous by the London police, who outlawed its use in town.

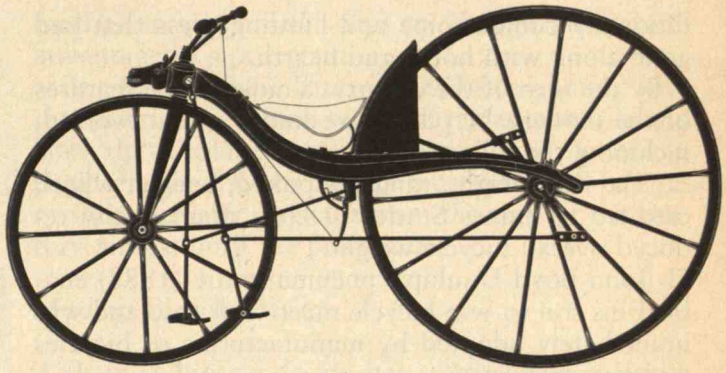
Balancing — The Unheralded Discovery

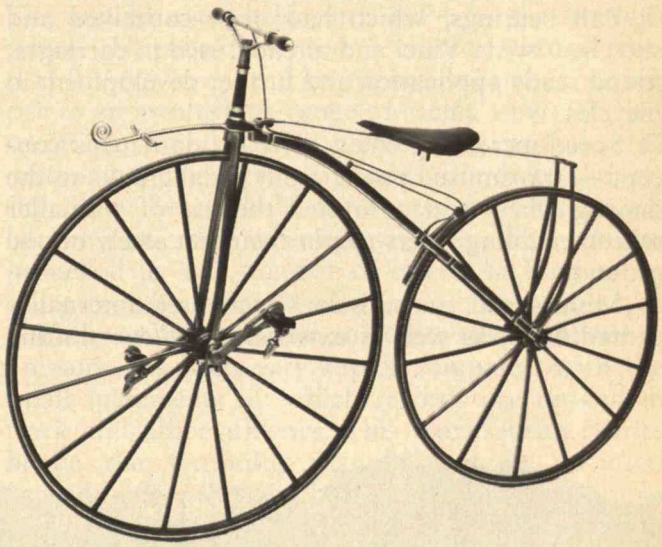
Velocipedes had a major disadvantage yet to be overcome — they were propelled by being pushed along with the feet on the ground. Opportunities to take one's feet up and to balance were strictly limited to the distance between successive strides and to downhill runs. The really outstanding discovery of this period, presumably made by von Drais, is neither recorded nor celebrated: one can maintain one's balance on a two-wheeler.

That finding led quickly enough to the true bicycle, propelled with foot-driven cranks. This innovation is ascribed to Kirkpatrick Macmillan, a Scotsman, who in 1839 used connecting rods to join swinging pedals on cranks to the rear wheel, which was larger than the front wheel. One swing of the legs could now carry rider and machine about four meters (twelve feet) — double the distance achieved by direct pushing on the dandy horse.

To obtain greater travel distance per pedal push, the driving wheel of the bicycle was made ever larger, until it evolved into the "high wheeler," also called the "penny-farthing," or "ordinary." Along the way the driving wheel position was reversed: pedals and cranks now drove the front wheel, which was perhaps five feet in diameter (it was made of a size to suit the rider's leg length, like pants), and a small wheel trailed behind. These light, fast, efficient, graceful, and horribly dangerous machines — tumbles were frequent and broken skulls and necks were all too often a consequence — became perhaps the first truly popular craze of the western world.

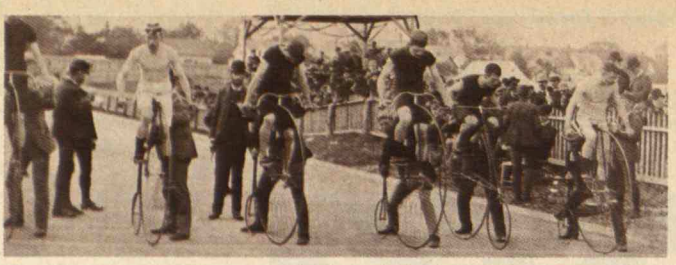
Bicycling's influence on the lifestyle of the middle class in the late 1800s was enormous (with mass production still two or three decades away, bicycles were too expensive for the poor). Mobility was suddenly, dramatically available to people who delighted at the chance of touring the countryside on a regular basis for the first time. Women stood to gain especially, as they escaped on their bicycles from purely domestic roles and began to shed the tra-





Top: The first pedalled bicycle, built in 1839 by Kirkpatrick MacMillan, an engineer in Courthill, Dumfriesshire, Scotland. The 57-pound machine was involved in the first traffic citation ever given to a cyclist, after MacMillan rode it into a child. The Glasgow Police Court fined him 5s. od. (Drawing: Alan Osbahr, in *Early Bicycles,* Philip Sumner, London: Hugh Evelyn, 1966)

Directly above: A velocipede — known then also as a "bone-shaker" of the 1860s. The front wheel was turned by fixed cranks. (Smithsonian Institution)



ditionally cumbersome and limiting dress that had gone along with home and hearth.

By the turn of the century, almost all the features of the modern bicycle as we know it had evolved, including the following.

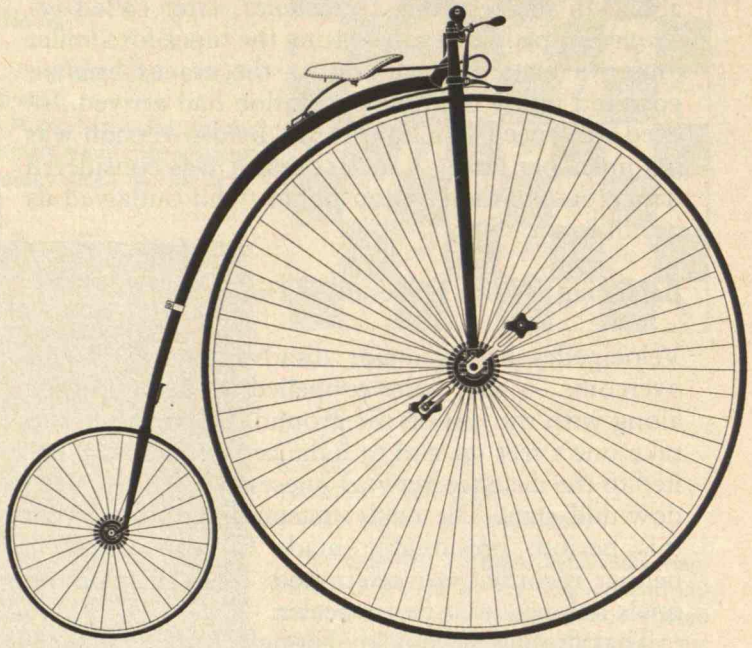
☐ The lightweight, tangent-spoked, tension wheel, credited to James Starley (1876), dramatically reduced overall bicycle weight.

☐ John Boyd Dunlop's pneumatic tire (1888) enabled his son to win bicycle races with ease and was immediately adopted by manufacturers of bicycles and automobiles.

☐ Ball bearings, which had been conceived and sketched by da Vinci and already used in carriages, found ready application and further development in bicycles.

☐ Speed-increasing chain drive — da Vinci's concept — transmitted power from pedal cranks to the driving wheel and permitted the use of a smaller wheel, enabling riders to put their feet safely on the ground.

☐ Multi-speed transmissions that used internally-geared hubs, as well as external *derailleur* shifting



Left, top: Professional "ordinary" racers at Springfield, Mass., meet in 1886. White-suited rider on left is John S. Prince, the first American professional cycling champion. Star bicycle, second from right, had smaller wheel forward.

Left: Bayliss-Thomas ordinary, 1879. It weighed 49 pounds. (Drawing: *Early Bicycles*)

Below: Longhand notation, "Ladies' Tour at Swampscott, 1877" appears on the original photo.

Above: No chain was used on the sanitary, shaft-driven, rear-suspended Pierce bicycle, 1900. In time, the Geo N. Pierce Co. became Pierce-Arrow. (All photos: Smithsonian Institution)

mechanisms, enabled riders to change mechanical advantage to suit terrain.

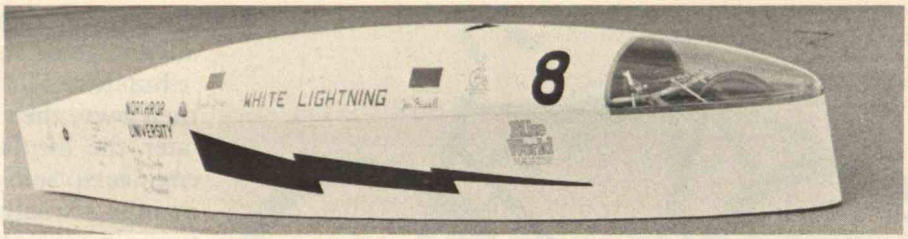
But just as these innovations were coming into their own, the exciting world of the automobile and later the airplane attracted bicycling's pioneering engineers. Sadly, the art of bicycle design has remained virtually stagnant from the turn of the century almost until the present day.

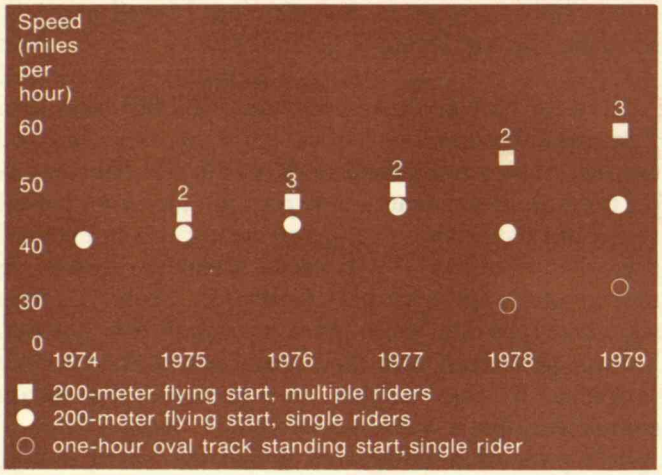
Modern Bicycle Design

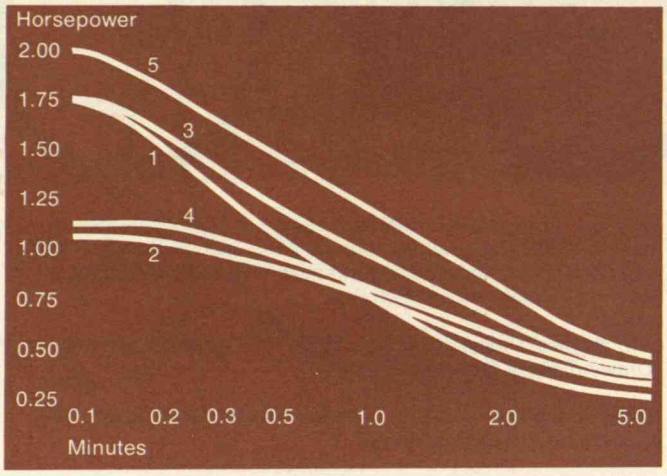
A thaw in bicycle design has started only recently. The annual races held since 1974 by the International Human-Powered Vehicle Association (I.H.P.V.A.) have been an important catalyst, giving rise to an astonishing range of racing HPVs. The association, founded by Chester Kyle, professor of mechanical engineering at California State University, Long Beach, holds its annual contests among human-powered, wheeled vehicles that can be propelled by any number of riders, so long as no energy storage is involved.

The pace of development under this competitive pressure has been very rapid, compared with the small increments by which records are broken in track and other athletics. This year, several entries broke the symbolic 55-mile-per-hour national "speed limit"; the next barrier: 60 miles per hour.

When Professor Kyle organized the human-powered vehicle races, he did not confine competitors to the restrictive design formulas used in most bicycle racing circles. Within a couple of years all the







races were being won on recumbent designs, on which the rider sits with feet forward, rather than in an upright posture.

Recumbent bicycles aren't new. The first modern recumbent in the U.S. was made by a "Mr. Brown" and taken to Britain in 1901, where it was received with derision although acknowledged to perform rather well. Then in France during the 1930s, an unknown rider on a recumbent *Velocar* proceeded to break speed records and even to beat the world cycling champion in one-to-one contests. The response? The International Cycling Union met in consternation and announced that the Velocar "was not a bicycle" and had therefore not broken any bicycling records. It was summarily banned from further competition.

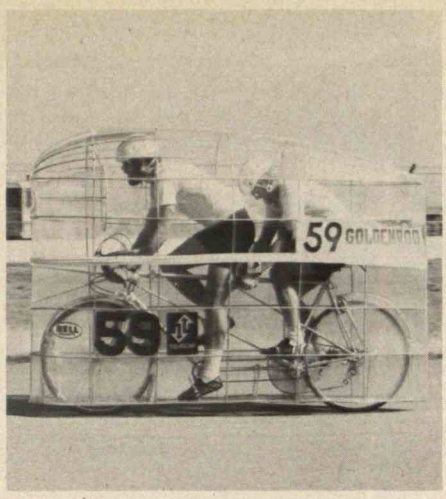
Unfortunately, recumbent bicycles designed for racing are not suitable for commuting with briefcase or shopping bag down Main Street. However, they are on the cutting edge of development and point to the way in which bicycles can be modified to make them more efficient, more comfortable, and safer.

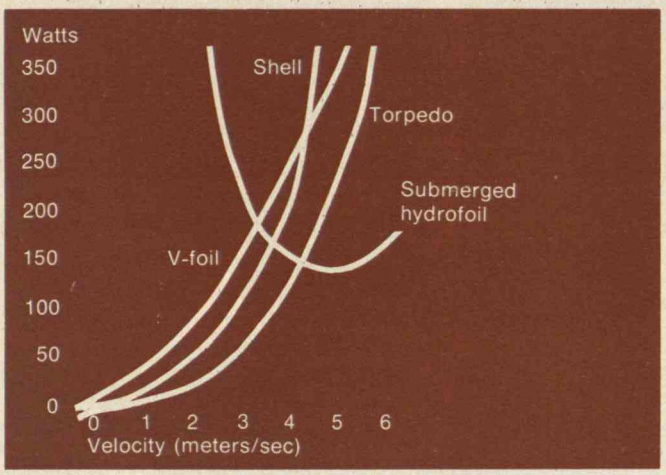
I became interested in the safety potential of recumbents after reading about the deaths of several prominent bicyclists, including racing champions, in head-first accidents with conventional bicycles. After building a prototype, rather to my surprise I found that the recumbent configuration was not only vastly safer from this danger, but that it was also much kinder to the human frame, could carry luggage more conveniently, and had less wind resistance. In addition, it could also be easily fitted with streamlining that would provide weather protection; more effective brakes could be fitted without risk of inducing more head injuries because in a panic stop the rider tends to be deposited feet-first on the ground.

Successes in the Air

The dream of human-powered flight was celebrated in many of Da Vinci's sketches, but has proved elusive indeed. Only two well-celebrated human-powered aircraft designed and built by a group led by Paul MacCready of AeroVironment, Inc., in Pasadena, Calif., have achieved great success and notoriety, winning prizes totalling £150,000. The purse was proffered in two challenging contests by Henry Kremer, a British industrialist. In 1959 he offered £5,000 (about $20,000 at the time) to the first group to fly a human-powered aircraft at least ten feet from the ground through a figure-of-eight course around two pylons placed a half-mile apart; he later raised the prize to £50,000. Team after team produced planes that could fly in straight lines and make small banking curves, but failed to negotiate the severe Kremer test. In 1977 MacCready's *Gossamer Condor* design succeeded for three reasons.

☐ It incorporated sophisticated aerodynamics (also used by many of the others).





Photos: Competitors in the 1978 and 1979 International Human-Powered Speed Championship races (photos by Chester Kyle, except as noted). *Opposite page, left and bottom: White Lightning,* the first unaided bicycle to break the 55 m.p.h. barrier (it turned 55.85 m.p.h.); *upper right:* double-prone tricycle without its streamlined shell. *This page, left:* streamlined standard tandem bicycle; *upper right:* partially-streamlined "manuped" with both foot and hand cranks; *above: Vector 82,* the fastest unaided HPV in the world, powered by three tandem riders to 57.07 m.p.h. (Photo: Julian Baum)

Charts: *Left:* Best times made in three events of the 1979 International Human-Powered Speed Championship races. *Middle:* The variation of power with time, produced by one subject in 5 testing modes: (1) cycling, (2) and (3) free and forced rowing, feet fixed, (4) and (5) free and forced rowing, fixed seat. *Right:* Power required to propel 4 types of hulls to various velocities in calm water.

☐ It was designed to fly at a slow cruising speed and therefore had a smaller power requirement: only 3.6 meters per second (8 miles per hour) in contrast to 6 to 9 meters per second (13 to 20 miles per hour) used by most other competitors.

☐ Dr. MacCready designed his airframe to be rebuilt in a matter of hours or even minutes after a crash. By rigorously testing each version of the design, analyzing errors, and rebuilding, his group was able to accomplish in one year what the others had failed to do for 18 years.

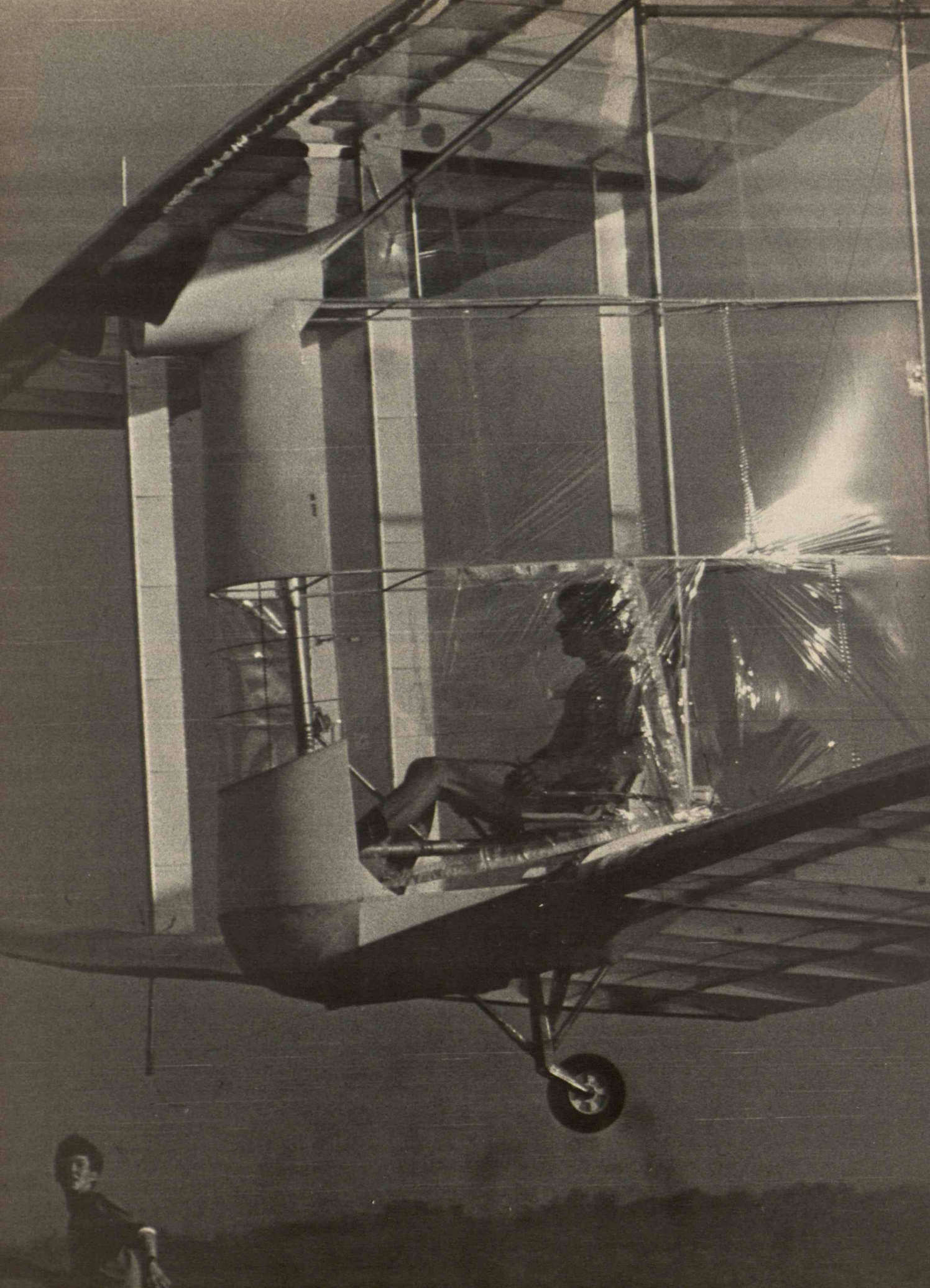
Henry Kremer then offered a prize of £100,000 ($180,000) for a human-powered flight over the English Channel. This time his prize went unwon for barely one year. Last June MacCready's *Gossamer Albatross*, weighing in at under 60 pounds, went the distance on its first attempt.

To minimize the load on its pilot, the delicate craft demanded only about 375 watts for take-off and climb, and 250 watts for cruise, achieved principally by its slow cruising speed (about 3.6 meters per second, or 8 miles per hour). But the maximum wind speed in which such an airplane can be flown is only around 1 to 2 meters per second (2 to 4 miles per hour) — practically a dead calm — because ground-level air turbulence has vertical components approaching wind speed. A modest gust of 4 to 5 meters per second (9 to 11 miles per hour) may severely damage a flimsy, low-speed aircraft even if it is held down and not allowed to become a kite, which it would want to do. Such periods of calm typically occur only in the hour or two near dawn on very still days. As a result these aircraft cannot go far from their hangers, in which they must spend most of their time.

There will be small improvements in human-powered heavier-than-air flight, but because of physical constraints HPT in the air must be limited to the areas of sport and recreation. Improvements will be slow in coming because physical limits are being approached. For example, at a weight of under 60 pounds, the *Gossamer Albatross* is already a fraction of the weight of the pilot.

For the present, there is no doubt that HPT flight must be regarded as an expensive prospect with great limitations. But improvements and innovations could change that. Some possibilities including foldable designs that could be boxed and transported would eliminate high hangar costs, and lighter-than-air lift from helium, hot-air, or possibly hydrogen would reduce the required lifting power and allow more to be devoted to propulsion. An inflatable airplane is a possibility. Furthermore, the low-gravity fields of large space colonies, say one-sixth to one-tenth that of earth's, could make HPT in the air practicable there even for relatively high-speed flight.

The most likely way to improve the performance of a human-powered aircraft is to improve its powerplant. Undoubtedly the best athletes will get even



better — they always have — but can we improve the average human power producer?

The answer is probably yes, but the more important question is, how much can the combination of the human motor and mechanical transmission in aircraft — and other HPVs — be improved? The data we have are derived necessarily from such combinations. Some of the best are from J. Y. Harrison of the University of New South Wales, who compared human-power production in bicycling and in various types of sliding-seat rowing motions. His findings show a peak power output range of about 0.6 to 2 horsepower (500 to 1,500 watts) among a number of subjects, which dropped within five minutes to about 0.3 to 0.5 horsepower (250 to 375 watts) in all cases. All subjects performing "forced" rowing motions, in which the mechanism forces the feet to reciprocate, produced up to 25 per cent more power throughout the tests than they did when bicycling.

Unfortunately, research findings of this sort have not yet been applied rigorously to HPV designs. And no tests have been made, to my knowledge, of the effect of using mechanisms geared specifically for the delivery of muscle power by non-athletes.

Slow Progress on the Water

Rather surprisingly, in contrast to the fairly steady thread of development of other HPT modes, there has been no pattern of progressive innovation in human-powered water vehicles since the development of the modern racing shell. The body is capable of giving out most of its energy through the leg muscles: yet throughout history most human muscle power has been applied through the arms and back. Moreover, these muscles have usually been worked at totally unsuitable rates of application. That is the case, for example, in the slow pushing or pulling of oars from a fixed-seat rowboat; arms are better suited to rapid cranking. The sliding-seat racing shell was, therefore, a major development.

To a casual observer, the principal difference between a conventional rowboat and a racing shell is the length-to-beam ratio, which may in the latter be as high as 50 to 1, arrived at to give minimal combined wave and skin-friction drag. But the real innovation is that the rower's seat slides forward and aft, permitting the rower's energy to be delivered principally by the leg muscles instead of by the arms and back as in a rowboat.

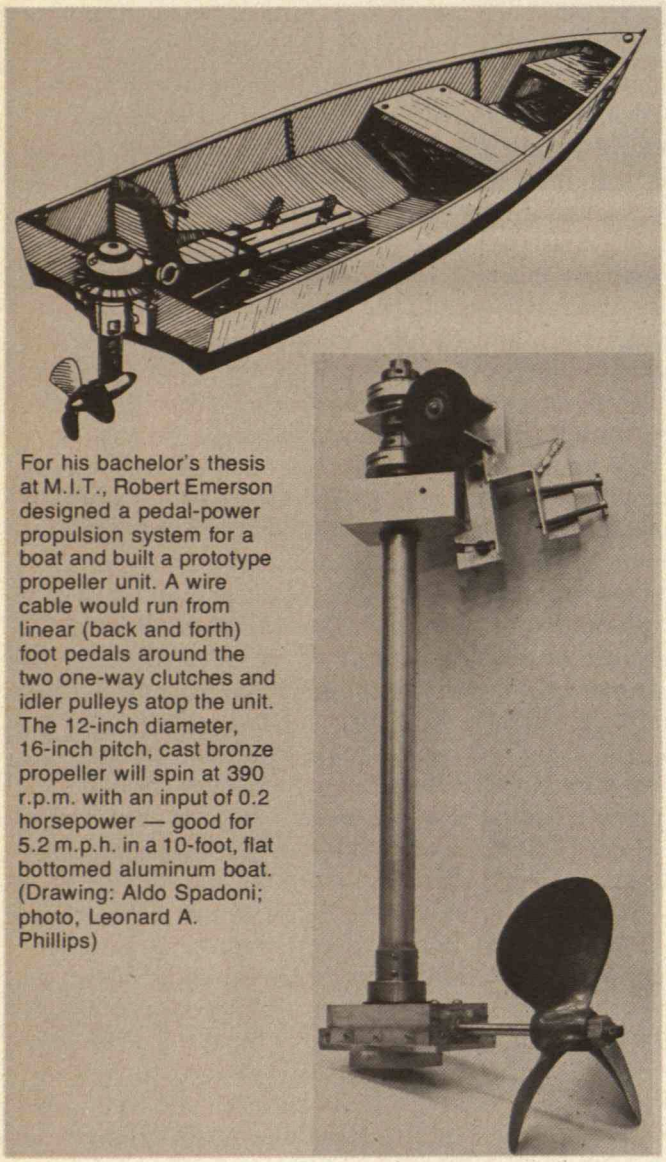
Why not other leg-driven propulsion schemes? Certainly existing forms of human-powered water transportation could be improved. Reciprocating oars, sculls, and paddles are wasteful of energy: the relative kinetic energy of the boat, the oars, and the very rower or paddler are reversed every half cycle by muscle energy. During the return stroke, oars cause high wind drag. During much of their movement through the water, oars dissipate energy into side thrust, which must be resisted by opposing oars or by rudders and fins, introducing more drag; the skilled canoeist's "J-stroke" produces similar advantages and disadvantages. And dangers abound: if, because of misjudgment or an unexpected wave, an oar comes out of the water when the rower is pulling hard, or catches the water unexpectedly during its return, there is a risk of upset and potential tragedy. And oars and paddles are inconvenient: one's hands are fully occupied while underway so that one cannot easily hold a rudder or tiller, a fishing rod, or lunch.

All of these problems could be avoided by the use of pedal-driven screw propulsion, a nineteenth-century innovation that is impatiently awaiting "reinvention." Indeed, in principle pedal power has none of these disadvantages. In the 1890s leg-powered, propeller-driven shells proved superior to oar-propelled boats in races between the two types of craft on the Seine in Paris and in the Thames in Britain. But the innovation was not pursued, despite its considerable promise.

Two modern applications of screw propulsion could be especially appropriate and fruitful: utility use and racing. The utility boat is used for ferrying to a boat out at mooring. Or for a day's fishing out in the harbor or the lake. Or for fetching groceries for an island home from the mainland shore. All of these duties used to be served by conventional rowboats, but nowadays we use small outboard-engined boats, which consume gasoline and oil and are often noisy, polluting, and unreliable.

Only modest development is needed to engineer a modern, efficient, outboard screw drive that could be swivelled to provide high maneuverability. Such a boat with an efficient propeller (an appropriate

Chrysalis, a human-powered, 72-foot wingspan, tractor biplane built at M.I.T. by Robert Parks, Harold Youngren, John Langford, Hyong Bang, and Mark Drela under the direction of Professor Eugene Larrabee. It flies at about 10 miles per hour. (Photo: Steve Finberg)



For his bachelor's thesis at M.I.T., Robert Emerson designed a pedal-power propulsion system for a boat and built a prototype propeller unit. A wire cable would run from linear (back and forth) foot pedals around the two one-way clutches and idler pulleys atop the unit. The 12-inch diameter, 16-inch pitch, cast bronze propeller will spin at 390 r.p.m. with an input of 0.2 horsepower — good for 5.2 m.p.h. in a 10-foot, flat bottomed aluminum boat. (Drawing: Aldo Spadoni; photo, Leonard A. Phillips)

propeller has been designed by Eugene E. Larrabee of the M.I.T. Dept. of Aeronautics and Astronautics, who also designed the propellers of the *Gossamer Albatross* and the M.I.T. human-powered airplane *Chrysalis*) could easily travel at one meter per second (2.2 miles per hour). The power input to the pedals would be only about 75 watts at this velocity — a level that ordinarily active people (not necessarily athletes) can maintain for an hour or two without strain.

The second application of human-power to water transportation could be through the high-speed sport or recreation boat. The 1890s racer was a twin-hull craft with the pedallers in conventional bicycling position on a framework high between them. M. Bradham Brewster, an M.I.T. student in the Class of 1979, studied this and two alternative configurations for his bachelor's thesis. One alternative, using a single submerged low-drag hull for most of the buoyancy and outrigger pontoons for stability, is an old favorite of mine; the other uses hydrofoils, the suggestion of Professor Patrick Leehey of the M.I.T. Dept. of Ocean Engineering. On paper the hydrofoil is the faster design, able to attain 4.5 meters per second (10 miles per hour) with a power input of about 200 watts. Athletes such as racing cyclists capable of producing 375 watts for an hour or more could probably propel the design to over 7.5 meters per second (17 miles per hour).

What might competition — or a new Kremer-type prize — do for the development of this propulsion system? I predict that the new sport would rival the popularity of hang-gliding and waterskiing.

Obstacles to Practical HPT in the U.S.

Today's multi-speed bicycle is a miracle of lightness, efficiency, and convenience: why isn't it used more? Daily trips of appropriate length are extremely common in the U.S. today: over half of all Americans' trips are less than five miles long, and about 30 per cent of our gasoline is consumed on trips of three miles or less. Except where climate or terrain is extreme, such distances are well suited to the modern bicycle. Factors that have kept the bicycle's popularity low in the U.S. include the following.

☐ *The competition*. The automobile is a superbly designed, versatile, robust, easily controlled vehicle that can transport people and belongings with no effort, in luxurious comfort, at any reasonable speed, over great distances, and at a low price.

☐ *Economics*. We have chosen, through acts of commission and omission, to subsidize the automobile — including highway systems and fuel — very heavily. Thus, the perceived cost of automobile travel is erroneously low. Real costs are enormous: the general taxpayer and homeowner foot the bill for roads, police protection, the disruption of travel and living patterns, air, water, and noise pollution, and for other adverse consequences of our dependence on automobiles.

Here at M.I.T., for example, we provide very expensive, guarded parking garages for staff who live in suburban communities, but offer minimal facilities for safe bicycle parking. I have calculated, with some sadness, that my desire to live close

enough to M.I.T. to be able to bicycle there comfortably makes me the equivalent of $10,000 per year poorer in apparent income because of the necessarily higher real-estate taxes and poorer services of a central city. "No good deed goes unpunished." The answer: charge automobile drivers with the full costs of their activities. Then more would bicycle.

☐ *The hostile nature of the highway.* Most of our older roads were upgraded and paved in response to the lobbying of bicyclists in the 1890s. As automobiles took over, the highway became hostile to nonmotorized travel. Today's bicyclist must travel as near to the right of the road as possible, where motoring revellers throw beer bottles, cans, and all sorts of trash and debris; where the doors of parked cars are vigorously snapped open by drivers usually — but not always — oblivious of the danger to passing bicyclists; where sewer gratings are often set inches below or above the road surface, like a trap set and waiting to catch a bicycle wheel and break the neck of the unwary; where potholes go unrepaired and gravel, stones, and piles of sand go unswept. And, perhaps worst of all, the cyclist on a road exactly two lanes wide must either hold ground and be a nuisance to drivers and perhaps a target for their vehicles or be continually dismounting and jumping out of the way.

The answer is not separate bicycle paths, which are too expensive for urban areas, never wide enough, and usually shared by pedestrians and parked trucks. The best answer, where it can be implemented, is a half lane to the right of the automobile travel lanes on regular roads (obviously not on high-speed superhighways). In many places such a half lane can be provided at little cost by reducing existing extra-wide lanes to a narrower standard width.

☐ *Thieves.* We have better bicycle locks nowadays, but a determined professional thief is still hard to stop. Yet, until recently, even the U.S. Department of Transportation failed to provide secure parking facilities for its Washington cyclist employees and prohibited them from bringing their machines into their offices. When one has had five or six expensive, personalized bicycles stolen (I have) because of the lack of secure storage facilities coupled with public apathy at the sight of thieves at work, one's enthusiasm for saving energy and the environment can be diminished.

☐ *Attackers.* Bicyclists have long known the punches, bottles, and oral brickbats thrown from

An Englishman's Nostalgic Look Back

When I was graduated from Birmingham University in 1948, I went to Loughborough in Leicestershire to do my two-year post-graduate apprenticeship at a manufacturing plant. I often think back to the pattern of life in that town, a pattern largely shaped by the available transportation, and wonder if my reveries provide a vision of the future, or whether in fact I am remembering an idealized existence through rose-colored, retrospective glasses. Judge for yourself.

The town's population was 27,000. From the house in which I lived I had a view over the unspoiled beauty of Charnwood Forest, through which I often took an evening walk. I was five to six minutes away from work by bicycle. The plant was confined on the far side of town by a railroad embankment, beyond which were green meadows, and unspoiled villages with names like Willoughby on the Wolds, Nether Broughton and Old Dalby. I used to eat my lunch sandwiches in a meadow while gently fighting off the loving attention of a group of friendly calves.

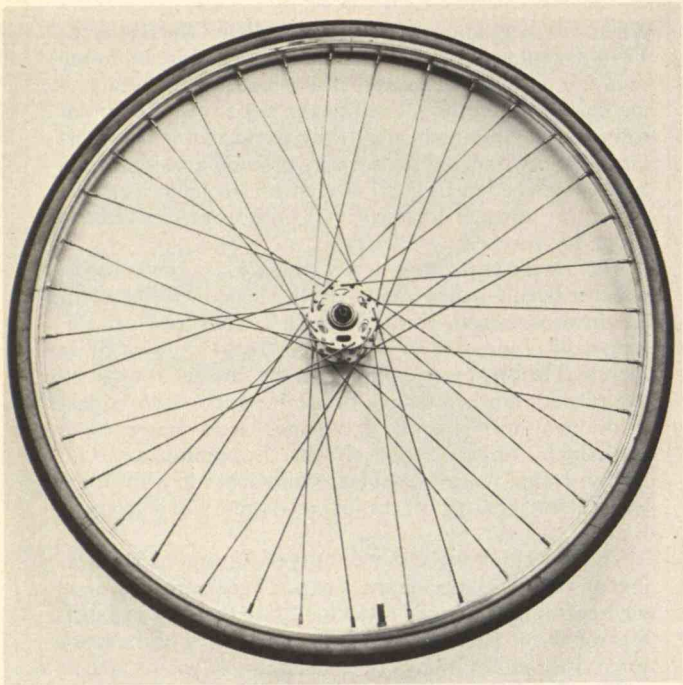
The firm employed about 5,000 people, and had a parking lot, never full, for about 20 cars. There were, however, well-patronized covered racks for 2,000 bicycles and shelters for about 10 motorcycles. The remainder of the work force came either by bus or walked.

Travel was unrushed and convenient. A modest traffic jam formed at quitting time and lasted perhaps five to ten minutes, but I never remember being held up for more than a minute or so. The town had a live theater and some music, but frequent fast trains could take you to Nottingham or Leicester in 20 minutes and to London in about an hour and a half.

I remember one of the most pleasant features of so much walking and bicycle transportation was that one was constantly calling out or waving greetings to friends. This is surely a vital part of the human condition, which the automobile has removed from our lives and replaced with the potential for hostility towards other depersonalized beings encased in their own metallic mammoths.

Is my recollection of Loughborough really idealized? I think it is not, and that new designs and supportive enthusiasm for human-powered transportation could restore a missing and very necessary human component to life in the U.S. — *D.G.W.* ☐

David Wilson and his latest recumbent bicycle. (photo: Leonard A. Phillips)



Typical modern tangent-spoked, tension bicycle wheel. Except for its modern lightweight materials, this wheel would seem quite familiar to a cyclist of the latter part of the 19th century. The weight of the bicycle frame and rider, applied at the axle, is suspended from the rim through the uppermost spokes; the remaining spokes act to keep the rim from deforming. (Photo: Leonard A. Phillips)

passing cars. I was once lassoed on Massachusetts Avenue by a sportsman in the back seat of a convertible. The noose fortunately fell across my shoulder rather than around my neck. The editor of this article once narrowly escaped being struck by the door of a moving car opened to achieve that end, the act punctuated, incredibly, with an obscenity. It is quite conceivable that a fair proportion of bicyclists' deaths on U.S. roads are homicides. Joggers are now learning to experience similar attention.

☐ *Bicycle design deficiencies.* The bicycle itself is a delightful vehicle, but one with shortcomings, which include the following.

Safety provisions: bicycles are not as safe as they should be. An over-the-handlebars fall can all too easily result in a fractured skull and/or a broken neck, in addition to severe facial injuries.

Brakes: generally poor when wet.

Weather protection: none.

Luggage capacity: little or none built-in.

Wind resistance: ignored by designers, even though this is where most of the rider's energy is dissipated.

Discomfort: long-distance riders on today's "ten-speed" bicycles commonly suffer nerve damage in the areas which share the support: hands, feet and crotch. The recumbent bicycle eliminates these discomforts, but has yet to win popularity in the re-emerging HPT market.

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David Gordon Wilson is professor of mechanical engineering at M.I.T., teaching thermodynamics and mechanical design. He is president of Massachusetts GASP, a nonsmokers' rights group, a keen walker, and bicyclist.

We asked Americans:

'Will Industry Develop Energy-Efficient Technologies?'

Because Union Carbide's business depends on energy, our future growth depends in part on national policies that encourage new energy technologies. Since public attitudes help shape public policies, we commissioned a survey which included this question on industry's role in achieving greater energy efficiency:

"Is it your feeling that American industry will play a major role in developing methods to reduce the amount of energy it takes to produce the average product or do you feel that (it) will play only a minor role in this?"

Major role	65%
Minor role only	27%
Don't know	8%

Source: Survey conducted for Union Carbide by Roger Seasonwein Associates, Inc. May 1979 national probability sample, by telephone, of 1,000 adults.

Two-thirds say industry will play major role.

As the nation seeks ways to conserve energy by using it more efficiently, 2 out of 3 Americans feel U.S. industry will make a major contribution to the effort. Indeed, industry's energy conservation record to date is good, a fact acknowledged by the Department of Energy (DOE). Yet, in a separate question in the same survey, fewer than half the American public believe industry will do the job on its own.

Industry has made real progress.

Increasing energy prices since the early 1970's have given industry strong incentives to save energy—and to develop ways to use it more efficiently. And these incentives have produced results.

- U.S. industry now produces a unit of output with 18% less energy than in 1973.
- Petrochemical companies like Union Carbide have developed plastics and carbon fibers for auto parts to replace heavier materials previously used—making possible lighter-weight cars that use less gas. In 1978, the average new car contained 165 pounds of plastics—produced from less than 1% of overall U.S. petroleum usage. And that amount is expected to reach 350 pounds per car by 1985.
- Union Carbide has developed new energy-efficient technologies: Our new "H-process" produces low-density polyethylene with just one-fourth the energy of previous methods. And our new process for hardening metal parts can save enough natural gas each year to heat all the homes in a town the size of South Bend.
- Under a contract with DOE, Union Carbide has developed a low-cost silicon material for use in photovoltaic cells which convert sunlight into electricity.

Getting on with the job.

With higher costs and potential energy shortages, it is in Union Carbide's interest to continue to create new energy-efficient technologies. The job can be done better and faster by all of us if we answer the President's call to "join together in a great national effort to use American technology to give us energy security"—and if public policies provide positive support for this effort.

An important first step is to allow U.S. energy prices to reach world levels so that America no longer encourages inefficient use of energy resources. Realistic pricing fosters energy conservation and encourages development of both conventional and alternative energy resources.

Union Carbide already produces a pound of product with almost 20 percent less energy than we required in 1972, and by 1985 we are committed to achieving a 30 percent reduction over the 1972 base year. But even with conservation and more efficient energy utilization, our energy bill will still be more than $2 billion in 1979. The phased decontrol of crude oil prices now underway will clearly increase that amount. While we, like other consumers, don't welcome higher energy bills, we do see realistic energy pricing as a necessary step toward solving the nation's long-term energy problems.

This advertisement is part of a continuing series on public opinions and national concerns.
For more information, write for a complimentary copy of the national survey, "Public Attitudes on Energy." Address: Energy, Union Carbide Corporation, Box G-17, 270 Park Avenue, New York, New York 10017.

UNION CARBIDE

Soft and Hard Energy Paths:

by Michael Stiefel

Society seems to face divergent energy strategies, just as separate roads appeared before poet Robert Frost. But a political, technical, and philosophical analysis finds that a single energy path is unlikely.

The Talmud tells us an interesting story. In order to build the First Temple, King Solomon needed the *shamir*, a worm that could cut through pure rock. To acquire this animal, he had to capture Ashmedai, the prince of the demons.

For some reason, perhaps for future use or to impress people with power, King Solomon kept the prince of the demons captive even after the Temple was built. Ashmedai's benefits, however, carried some unexpected costs. He craftily usurped Solomon's power and disguised himself as the king. Fortunately, the High Council recognized the

The Roads Not Taken?

"king's" errant and immoral behavior, uncovered the imposter, and returned the throne to Solomon.

Technological choice is a very old problem. Even Solomon, the wisest of mortals, found that misuse of technology can produce unforeseeable consequences.

Our current energy problem must be viewed from this perspective. It is not only a quest to find new means to supply future needs; we must determine the effects of energy technologies on our lives. Technology should not be relied upon to solve social or ethical (non-technological) problems, although it can often alleviate or modify them. Nonetheless, all efforts to foresee the effects of technology are marred by uncertainty about the future, and even the present.

Roads to an Energy Future

Different definitions of the energy problem can produce different solutions. One highly comprehensive presentation, done by Amory Lovins in *Soft Energy Paths* and several other places (*see Suggested Readings*), provides a useful vehicle for analysis and

comment on the broad energy picture.

An energy strategy dictates that certain technological options be developed in contradistinction to others, and Lovins outlines two such strategies: he calls them "hard" and "soft" paths. These approaches are technologically compatible, but they are culturally and institutionally disparate. The hard path relies on the continued expansion of centralized technologies — especially electricity generation — to increase the supply of energy. In the short term, this approach uses oil and gas, coal (synthetic fuels), and nuclear fission; in the longer term, fission breeder reactors, nuclear fusion, and perhaps large-scale solar plants. Conservation is induced only by rising prices.

The soft path technologies, as defined by Lovins, use renewable energy flows, such as from the sun or wind, that are present whether or not we use them. They are diversified; each technology does what it does best. They are easy to understand, so that an individual can make up his or her mind about them and perhaps even build or operate them. And they are matched in scale, geographic distribution, and energy quality to end-use needs, such as lighting or heating.

An analysis of the U.S. energy consumption patterns shows that only 8 per cent of our energy uses require electricity, but we use electricity to meet 13 per cent of our end-use needs. Since the generation of electricity is an especially inefficient process, it consumes 29 per cent of our fossil fuels. Substitution of other energy technologies would be preferable.

Soft technologies include solar collectors for heating, small-scale and conventional hydro-electric plants and wind for electric power, biomass-based gas and liquid fuels, and industrial congeneration (the generation of electricity as a by-product of normally produced process steam). Fossil fuel systems are used during the transitional period.

In Lovins' view, the hard-path option will collapse, technologically and economically, under the intrinsic weight of massive energy waste due to conversion inefficiences, large capital costs, nuclear waste storage problems, weapons proliferation, and environmental damage. The pursuit of hard-path policies has manifest sociopolitical disadvantages: increasing autocracy, bypassing of traditional market mechanisms, concentrations of political and economic power, encouragement of bureaucratization, promotion of social alienation, enhancement of technical vulnerability, large social risks, and the establishment of an elitist technocracy.

These effects are seen as eroding the political institutions of a democracy. Soft technologies are viewed as more democratic. People who want to use them may do so; others are free to reject them. Soft technologies are rapidly deployed in a non-coercive fashion that avoids the hard-path problems. The small scale would largely eliminate electrical power-grid transmission losses and reduce infrastructure costs. Reliability would increase, eliminating the need for large reserve systems. Smaller systems should have shorter lead times, meaning less exposure to cost escalation and mismatched demand forecasts. The economics of mass production could be applied to widely-used small-scale systems. Lovins maintains that these advantages are intrinsic to soft paths and that a society devoted exclusively to soft-energy technology is needed to realize them.

The Democratic Process, Exclusivity, and Uncertainty

Under normal circumstances, the democratic process produces hybrid policies. Normative policy is incapable of making extreme choices, such as either hard or soft paths. Conflicting political conditions, institutions, and trends coexist within the same society. If our best choice for survival is a single energy path, we may have to realize, to use Walter Lippmann's phrase, that our democracy is no more divine than the kings before us.

Energy politics are complex. By no stretch of the imagination does a consensus exist — among legislators, bureaucrats, or the public — on such fundamental choices as rate of economic growth or the structure of communities, much less on whether coal, nuclear, or solar energy should predominate. The views of a few vocal, competing groups with divergent interests are usually emphasized in the political process. It appears simplistic to suggest that one set of goals and values, or a single resolution of goal and value conflicts, could dominate societal policy preferences. And even if agreement on such goals were possible, there would be very little agreement on how to achieve them.

Everyone wants clean air, for example. But this means different things to different people. To some it means the removal of pollutants detectable to human senses, to others an ever-decreasing level of impurities in accordance with the latest scientific standards. Despite a consensus of industry, politicians, and the public in Pittsburgh in the late 1940s on the magnitude of the problem, there never was a

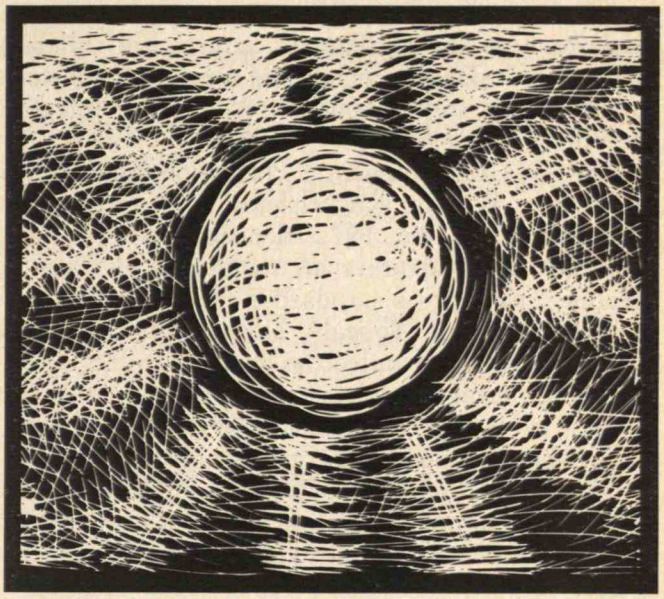
comprehensive plan for air pollution control in Allegheny County. The use of scientific expertise was limited, and gross remedies were applied only to immediate, observable problems. The public played a passive role. When better epidemiological data were obtained and the public took a more activist stance, any semblance of coherent policy disappeared.

Even if a plan to reach agreed-upon goals is created, its implementation will not be a simple matter. Planned economies find attempts to redirect their society difficult, if not outright futile. Our Sputnik inferiority complex created national consensus on a manned space program. But agreement did nothing to settle the sub-objectives of technical means or monetary allocation.

Lovins believes that "a soft path simultaneously offers jobs for the unemployed, capital for businesspeople, environmental protection for conservationists, enhanced national security for the military, opportunities for small business to innovate and for big business to recycle itself, exciting technologies for the secular, a rebirth of spiritual values for the religious, traditional virtues for the old, radical reforms for the young, world order and equity for globalists, energy independence for isolationists, civil rights for liberals, states' rights for conservatives." It should be noted, however, that progress in civil rights in many parts of this country was made precisely at the expense of states' rights. Does a soft path mean social regression? How do soft paths help in a rebirth of spiritual values? Many of the disadvantaged protest that limited future energy supplies will restrict social mobility and preserve the status quo.

A catharsis, created by a deep national crisis, might make this country susceptible to leadership it never would accept under other circumstances. But conflicts — between that new leadership and the built-in inertia of the pre-existing political structure — would be inevitable. The Depression and New Deal years may be an example. The Supreme Court, by declaring New Deal legislation unconstitutional, gave Roosevelt many problems. Despite his popularity and an apparent need to implement his plans, F.D.R. could not "pack" the Court with more members by mustering a simple majority in Congress. He found he could not tamper with an institution as fundamental as the high court.

Considering these difficulties, the most effective method for policy formulation might be to make incremental policy without clarifying long-range ob-



Even if
solar collectors are simple,
will this also be true
of the machines
that mass-produce them?

jectives. A course of action is devised and one analyzes how the legislatures, courts, and interest groups react. Depending on the results of this venture, the next step is constructed and presented to the policy process.

How was Environmental Protection Agency administrator William Ruckelshaus to determine the correctnesss of the 1972 decision to deny automobile manufacturers an extension of time in meeting air pollution standards? The District of Columbia Court of Appeals, siding with the auto manufacturers, remanded the decision to the E.P.A. Realizing the magnitude of the opposition and the possible economic consequences of strict regulation, Ruckelshaus compromised. He established strict interim standards and postponed the implementation of the 1975 standards for one year. No weighing of sociopolitical factors or abstract economics over the long term would help when confronted with overwhelming political forces.

Does this procedure represent moral appeasement? If so, there are two possible explanations: either the established institutions do not represent the electorate's views properly; or the electorate's views are morally bankrupt. Neither soft nor hard energy paths during the transition period would solve this problem, even if one or the other might bring Elysian Fields 50 years hence. Given the constraints of the political process, compromise will result; and where compromise leads, no one can say.

Society has always been a conglomeration of cultural and institutional antagonisms. The constraints of "ad-hocracy" and "crisis management" politics seem to mitigate against an exclusive energy path. Our regulatory process is a mixture of legislative, judicial, and executive directives that often work at cross purposes. Institutional reform, such as the removal of subsidies or the reorganization of electric rate schedules, is easier said than done: witness the continuing struggle over oil and gas deregulation. Cheaper utility bills with subsidies mean cheaper energy by the same political logic that subsidizes milk and many other items in our economy. It is politically easier to protect the poor with subsidies than to institute welfare reform. Such a working philosophy does not encourage belief in the politcal viability of a pure energy path. Whether this is a looking-glass situation depends on one's perspective. In any case, implementation of a political program requires a vision of a complex, interlocking chain of events — any of which can go wrong — leading to yet another tortuous chain.

Different analyses have arrived at different estimates of the costs of energy technologies. (Sources: Lovins (1977), Forbes, and McKinstry; see references.)

Estimates of energy costs ($1,000/barrel oil equivalent/day)

	Lovins	Forbes	Preliminary results of M.I.T. study
Nuclear power	200-300	132	173
Coal	170	120	139
Solar space heating	50-70	423	
Biomass alcohol	13-20	30	15-85

Technical and Economic Questions

The process of political accommodation is often made easier if the technical and economic uncertainties are few. We do not have such luxury.

Consider the market penetration curves in the figure on page 64. Irrespective of different economies and cultures, the "diffusion times" of new technologies seem about the same. Similar results have been found for some energy technologies, and in other areas. A 40-year time-lag existed between the first successful use of the tunnel oven and its widespread use in the pottery industry. More than 14 years elapsed before Iowa farmers fully adopted hybrid seed corn. It required 50 years for the idea of a kindergarten to be adopted by public schools. General Electric has just developed a new evacuated tube solar collector; now the company must organize a new consumer education and distribution network. The diffusion process is neither simple nor short.

In debating the technical and economic issues of hard versus soft energy paths, we must not forget that energy-saving methods (i.e., "conservation") and energy-efficiency improvements for accomplishing a given task ("Second-Law efficiency") are essential to both. Moreover, the selection of a soft-path technology — solar, for example — is not by itself a repudiation of the hard path.

Lovins' unit of comparison for energy technologies (introduced at the economic margin) is the dollar capital cost to construct equipment to produce one barrel of oil-equivalent per day (bbl. day). It excludes fuel and maintenance costs on the grounds that if the capital cost of a soft technology to perform a given task is lower than that of a hard

technology, it will certainly have a lower delivered energy cost because it has relatively smaller maintenance and operational costs and generally no fuel costs. In the specific case of using biofuels for running our automobiles, however, this assumption is not true. The competing demand for petroleum feedstocks may make price an important consideration.

The data uncertainties are immense, and are exacerbated by inflation, unforeseen contingencies, and wishful thinking. Consider the Federal Aviation Administration's experience with airport paving, for example. Despite the well-known and well-defined characteristics of the work, there is massive uncertainty in estimating costs. Similar results have been found in other civil engineering projects.

Underestimation of costs in military projects receives considerable publicity, but this is a general fact of life in public and private works. We have some experience with coal and nuclear power plants. However, we have relatively little implementation experience with the soft technologies. What are the research, development, tool-up, marketing, installation, and maintenance costs? Even if solar collectors are simple, will this also be true of the machines that mass-produce them?

The table on page 60 contains cost estimates for soft technologies from Lovins and two other sources. The plastic cover plates on today's collectors that sell at Lovins' assumed price have a tendency to darken with age and redden with exposure to ultraviolet light. Will they last 20 years? The prepackaged, high-efficiency, reliable collectors made with energy-intensive glass and aluminum sell for about $420 per square meter installed. If a solar space heating system lasts only 10 years, and a nuclear plant 30 years, one must compare $150,000 (not $50,000) with $200,000 (*see table at left*). The choice of discount rate is crucial. If one uses a negative rate, as Lovins suggests, nuclear power may appear advantageous.

A simple, sketchy calculation is illustrative. An average U.S. location receives about 180 watts of insolation per square meter. Lovins believes that 100 per cent solar space heating is possible with an investment, on the average, of $100 per square meter of collector *and* cubic meter of storage (assuming a mature industry in the mid-1980s and 1976 dollar value). He assumes a 42 per cent total system (not collector) efficiency. Hence, about 75.6 watts of insolation per square meter is available for use. We shall assume one square meter of collector to one

The Soft Path

"Nuclear energy is a technology of the future whose time has past," according to Amory Lovins, the author of *Soft Energy Paths*. Nuclear energy fails, in his view, to efficiently convert to baseload electricity the energy embodied in the nuclear power chain: in the plants themselves, in ore mining, in fuel processing and reprocessing, and in waste disposal.

What path energy? In Lovins' projections for energy use in the year 2000, soft technologies based on renewable resources will virtually replace conventional fossil fuel systems and could enable the U.S. to reduce total energy used by the turn of the century.

In contrast, a "hard energy" course relying on nuclear energy and disminishing supplies of fossil fuels could increase U.S. energy generation needs threefold, he told a crowded M.I.T. seminar last spring, because far more energy is needed to bring hard technologies on line — and keep them there — than is needed for soft technologies. And hard energy technologies, which are centralized, have two generic weaknesses: the hazard of widespread blackouts, and problems related to siting — especially those arising from the reluctance of small communities to accept power facilities that serve large cities.

"We all agree on the necessary use of renewable resources for the future," he said, but he warned that "the government must stop spending large amounts on subsidies of large-scale technologies" because "this is making the hard technologies look cheaper than they really are and is reducing the economic attractiveness of the soft technologies."

When Lovins began proposing soft energy paths in the early 1970s, his predictions of changes in U.S. energy use were criticized as unrealistically low, but they are higher than today's most conservative figures from industry and government sources. This proves, said Lovins, that "the choice of the soft energy paths is inevitable." — *Robert M. Wasserman* □

Year of forecast	"Beyond the Pale"	"Heresy"	"Conventional Wisdom"	"Superstition"
1972	125 (Lovins)	140 (Sierra Club)	160 (Atomic Energy Commission)	190 (Bureau of Mines; Federal Power Commission)
1974	100 (Ford Foundation Energy Policy Project)	124 (Ford Foundation Energy Policy Project)	140 (A.E.C.)	174 (Electrical Energy Institute/ Electrical Power Research Institute)
1976	75 (Lovins)	89-95 (Frank von Hippel; Lovins/ *Foreign Affairs*)	124 (U.S. Energy Research and Development Administration)	140 (E.E.I.)
1978	33 (Steinhart, *Fires of Culture*, Duxbury Press)	63-77 (Committee on Nuclear and Alternative Energy Systems)	96-101 (Institute for Energy Analysis)	124 (Ralph Lapp)

Evolution of U.S. energy demand forecasts for the year 2000 (in quadrillion B.t.u.s) as compiled by Amory Lovins. Note that today's most conservative estimates are equivalent to the most optimistic forecasts of 1972. Current demand is about 75 quads; the U.S. Dept. of Energy estimates about 100 quads will be needed in 2000.

cubic meter of storage; the optimal figure depending on a trade-off between storage and collector costs. In this case, the solar space heating system costs $100 per square meter of collector. The total system cost is $1.3 per watt, or $87,000/bbl. day.

Scaling these collector costs to a 100 per cent solar-heated house does not yield robust estimates. If the overall efficiency, for argument's sake, is only 35 per cent (instead of Lovins' 42 per cent), the cost is $106,000/bbl. day. If the collector system costs $150 per square meter of collector and cubic meter of storage instead of $100, the price is $133,000/bbl. day. With these figures, a capital cost tradeoff between solar and nuclear with heat pump ($99,000/bbl. day by Lovins' calculation) is no longer clear.

Using Lovins' estimates, the solar heating system for a poorly insulated house with a 4-kilowatt average load and 125 square meters of floor space, at $70,000/bbl. day, would cost about $4,200. A well-insulated house should have about half the load and would need a solar heating system costing about $2,100. In 1970, there were 40 million homes in the United States. If every home (this neglects apartments and offices) were retrofitted at $2,100, the cost would be $84 billion; this is about $1.7 billion per year for 50 years, a typical period for technology replacement. Current (low-level) spending on magnetic-confinement fusion research is about $300 million per year. Perhaps a reallocation to the latter is a better investment.

The real problem, of course, is not whether anybody is right or wrong. It seems that the uncertainty about cost and technology, which everyone acknowledges, precludes any exclusive commitment to any energy strategy, hard or soft.

It is well known that any physical system operates at best efficiency at less than maximum output. And optimal thermodynamic efficiency may or may not maximize economic efficiency or social, health, and environmental benefits. Capital costs need not be absolutely minimized if some other resource — such as labor, materials, or energy — is being used optimally, and there is general agreement, in fact, that a narrow economic calculus neglects social values.

The amount of conservation demanded by a realistic soft energy path may be immense. According to Lovins' estimate, we must improve efficiencies threefold so that the available waste biomass resource (itself uncertain) equals the demand for transport fuels. Will we do this? Is the elasticity of demand such that we will realize all the energy savings from the efficiency improvements? Will the public be satisfied with the trade-offs implicit in a high-efficiency car? Will people implement the necessary conservation procedures?

Moreover, soft technologies may not be as benign as one might imagine. Consider wood — the most traditional biomass fuel. New Hampshire is finding that emissions from wood burning degrade the ambient air quality. Regulation might be necessary to limit the number and type of wood burners. Our hard-path experience with anti-pollution devices is informative, and not encouraging.

Is a soft energy path technically and economically desirable? The preceding seems to indicate uncertainty. It is unclear whether people's time horizons are long enough for life-cycle costing. Individual self-interests must be considered, also, and they are often contradictory. Regulation of the solar industry seems likely to discourage innovation. Even enforcement of anti-trust laws could work against soft-path implementation — in the absence of realistic R & D subsidies or end-use tax credits, only a large firm such as General Electric can afford to temporarily price evacuated tube solar collectors at a loss to create a market for them.

In a world of limited resources, almost any goal is attainable if we give up the quest of enough other goals. How we choose now affects what will be available later. With doubt now, one hedges one's bets. And this implies a diminished likelihood of being able to elect an exclusively hard or soft path for the future.

World Views and Value Judgments

Human beings view the world in terms of constructs they impose upon reality. These constructs about the world are never proven or disproven; they simply become more or less reasonable to believe. The amount of evidence required to convince people of the incorrectness of their views is, however, strongly related to their *a priori* belief in the truth of their position. To mathematicians, this relationship is known as Bayes' Theorem.

If collections of constructs are shared by enough people — that is, are used by many people in understanding life — they can be considered what Thomas Kuhn has called paradigms. In the astronomical realm, two paradigms were the Ptolemaic and Copernican views of the solar system. The latter triumphed when its usefulness in explaining the natural world proved superior. Intuition, simplicity, and coherence with other theories were other impor-

In Lovins' view, the hard-path option will collapse under the intrinsic weight of massive energy waste.

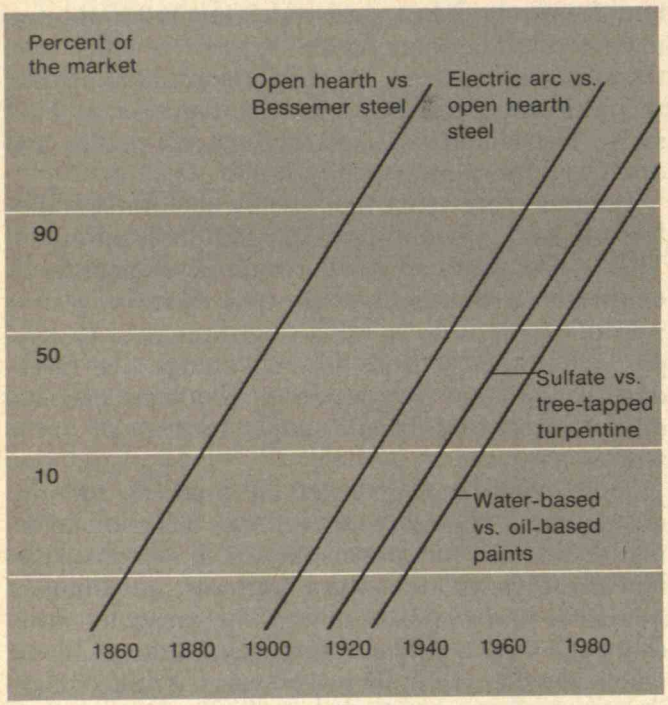
tant factors in the changeover. Scientists could not uncover the Theory of Special Relativity, which was there before their eyes, because they could not make the necessary paradigm shift; this required an Einstein. Hence, people's perceptions of reality are often as important as reality itself.

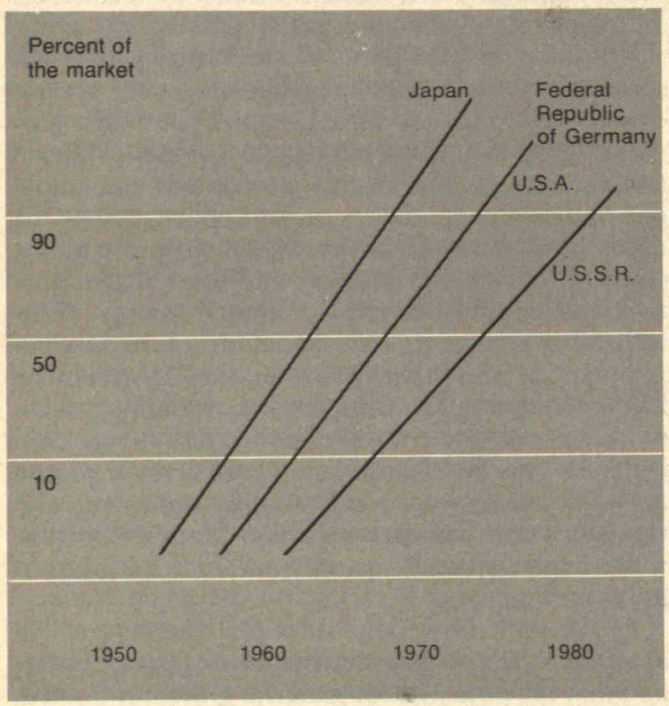
Various energy paradigms define the problem differently and, as a result, mandate different solutions. These social views are not based on pure scientific or empirical grounds but contain certain transscientific propositions. Diverse groups tend to talk past each other because different things are "obvious" to different people. Some problems become crucial, others irrelevant, simply because of one's world view.

Social views are reflected in political actions, technological choices, and everyday behavior. Normative politics operates mainly in this regime. Behind these views are cultural patterns, institutional structure, and values. On this intermediate level, change is most difficult. Important reforms have taken anywhere from 75 to 100 years. At the core of these paradigms are humans' views of themselves and their role in the universe.

Consider the viewpoint of the "hard path": the solutions to humanity's problems (such as unemployment and starvation) require continued economic growth and technological progress. Within this framework, the energy problem is essentially one of developing efficient, new supplies to meet the needs of a growing world. While we are running short of fossil fuels, there are sufficient alternatives that can supply virtually unlimited energy. Centralized government, and regulation to alleviate environmental and other inequities, will be necessary. Life's psychological complexities, stemming from industrial society, are the price we pay for modern benefits. This hard-path view is not limited to any form of government; it is shared by right-wing dictatorships and democracies alike. Marxist thought, surprisingly, is based squarely within the notions of growth.

A soft path view holds that real human growth must be in the social, cultural, and spiritual areas; and that the potential for material growth is limited. Because energy is but a means to an end, "appropriate" technologies emphasize the ability to realize social goals such as energy frugality, political decentralization, and environmental neutrality. Within this framework, the energy problem is how to meet, in the most efficient manner, the heterogeneous energy end-use needs. The use of coal is limited by





These charts suggest timespans that might be required for one new, competing energy technology to replace another. The chart at the top illustrates the process of technological substitution in the production of steel, turpentine, and paints. The chart below it shows the replacement of the open hearth and Bessemer steel processes by the basic oxygen furnace in four countries with varying economic systems. (Sources: Fisher and Pry; and Pry.)

social and ecological constraints. Nuclear power is handicapped by problems of weapons proliferation, safety, and lack of public acceptance. Dependence on foreign oil is dangerous from the standpoint of economics and national security. Energy policies should emphasize conservation and development of renewable sources, such as the sun and the wind.

As is clear, we are describing typologies. There is a wide spectrum of views, ranging from warnings of imminent ecological disaster to the one that holds that the energy crisis is an oil company deception.

On the level of normative politics, the claims of the various paradigms ought to be verifiable by everyday experience. Paradigms make conflicting claims about how certain institutions are affected by inflation or by the cost of solar collectors, for example. These claims are then compared with what happens in real life. Usually, however, as in science, negative results cause only slight adjustments in paradigms or produce disclaimers about the validity of experience in a particular case because of external factors. Yet in real life, liberals do become conservatives and religious individuals do become skeptics.

What is needed is a series of "critical experiments," on an intermediate level, that could distinguish between paradigms and help people determine which options are reasonable and which ones are not. William James, in *The Will to Believe*, developed several criteria: to be a genuine option, it must be living, forced, and momentous. *Living* means a willingness to act irrevocably. A choice between Theosophism and Confucianism is probably a dead choice, a choice between agnosticism and Christianity is probably a live one. If one says, "Pick up this book" or "Do not pick up this book," there is no *forced* option. Similarly, if one says, "Call my theory true or false," the choice is avoidable. But if one says, "Accept this truth or go without it," the choice is forced. A *momentous* option is one in which the chances for another opportunity are small; a trivial option is one where the stake is insignificant or the decision reversible. If one refuses a momentous opportunity, it is as if he or she had tried and failed. A chance to go on a Mars expedition is momentous; a trip to the library is probably not.

If there is to be social stability, some values must be shared at some point by different paradigms. Society must decide what it considers acceptable social change for the energy future. The amount of future energy needed by society must be decided; this is crucial for the hard-versus-soft choice. Nuclear

power must be accepted or rejected — to delay or to refuse to choose is effectively to reject.

Unaccepted paradigms and values may disappear, as absolute monarchies did in Europe; or may reemerge, as religion did, as a strong social force. Out-of-fashion paradigms are often called superstitious or fundamentalist.

The central themes of world views are seldom actually tested. They may be rejected when their intermediate or normative policy propositions become untenable, in spite of the paradigm readjustments that might maintain their viability.

Advocates of the hard path would argue that energy-supply limitations mean little to those who are starving. Those who side with the soft view contend a hard path is immoral energy gluttony. The value of electricity as a versatile energy form is a paradigmal proposition. How much bet-hedging is required for decisionmaking depends on one's willingness to take risks and one's evaluation of the probability of success of the alternatives. These views are paradigm-dependent.

Lovins' technical arguments are an attempt to present his case within the structure of the hard path. Yet technical, economic, and political considerations lead us to believe that under normal political circumstances there will be no pure path.

Will a paradigm shift emerge? It was not until 280 years after the death of Jesus that Christianity obtained favorable status in the Roman Empire. Yet Emperor Julian attempted a pagan revival a decade after the death of Constantine; it failed, partly due to the brevity of his regime. It was not until 70 years later that Theodosius I ordered all his subjects to become orthodox Christians; participation in any pagan cult was declared to be treason. It took hundreds of years for feudal kingdoms to evolve into nation-states. A century elapsed between the earliest steam engine designs of Denis Papin and Captain Savery to the emergence of England as a technological power. It was 70 years from the *Communist Manifesto* to the Russian Revolution. The time needed for a paradigm shift seems to be decreasing. On the other hand, there are numerous paradigms that never made it.

Let us try to see what Lovins has accomplished. Soft and hard paths may not coexist within the framework of Aristotelian logic; but human beings are not bound by the Law of the Excluded Middle. The "crucial experiments" of the soft energy path need not be completely successful to be of value in formulating people's views.

Several "results" are already well established: increasing energy consumption does not necessarily mean increasing prosperity, nor is decreasing energy use necessarily equivalent to decreasing the quality of life. Certainly we should view our energy resources, such as coal and oil, as non-replenishable capital stocks; and renewable energy sources, such as the sun and the wind, as annual income. Prudent individuals attempt to live off income and only dip into savings when necessary. Nonetheless, while big may not be always better, certain hard-path growth attitudes — not necessarily technologies — may have to remain for awhile to correct imbalances between haves and have-nots. (Consider, for example, the distributional inequities in world-wide consumption of petroleum.)

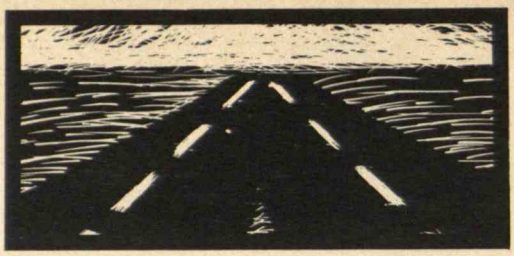
Lovins has contributed to the adversary process that is essential for policy development. It is unhealthy for decision-makers to become complacent; individuals outside the prevailing paradigm are vital. Probing the assumptions of the hard path advocates, Lovins has shown flaws and self-satisfaction with incomplete plans to be prevalent.

Most revealing, the quality of the response to his interwoven sociopolitical and technical arguments has often been poor. A good illustration is the nuclear power issue: the uncertainty surrounding people's acceptance of nuclear power is on social and psychological grounds. Proponents argue technically, but to deaf ears. By the time the public begins to sort out the arguments, nuclear power suffers a severe setback. Only now are reactor supporters realizing they have relied too long on old, simplistic approaches.

While Lovins is correct in emphasizing the importance of technological structure, such as centralized control of electricity, it is not the only criterion. Large corporations are ideally qualified for mass-producing the many units needed for decentralized systems. Small may be beautiful; but everything ages, and the beauty of youth turns into the weariness of age. Small businesses turn into oligopolies that become monopolies.

Will this happen to decentralized solar or windmill industries? Only big labor can compete with big business. Big government is needed to regulate both. What is to prevent soft energy technologies and institutions from being co-opted or corrupted?

If our foreign affairs commitments are to be maintained, a strong central government will be needed. Who would have provided remedies in times like the



Depression — or can one guarantee this would not happen in a soft-energy world? Who will regulate the national financial network or the centralized power plants Lovins admits will remain? How can one eliminate the social effects of mass communications?

As long as regulatory and economic power is concentrated in Washington, most of the tensions and disadvantages of our society that Lovins finds disagreeable will remain. This does not mean we cannot alleviate matters by adopting some soft technologies. However, technical fixes are insufficient to solve social problems. As John Adams pointed out, any society will have an aristocracy in whatever its people value.

After all, it is people who make up society, not technical structure, and human fallibility will intervene. What will happen when, to quote Huxley as does Lovins, soft paths become superstition instead of heresy?

Humans are dialectical beings, with antithetical desires. They are cosmic, creative, technological beings. They are also societal and spiritual beings. As a result, one cannot build ethics into a system. Morality, as Socrates knew, must be taught by example, not only by education. No technological or political structure will accomplish this.

The energy technology debate is a misnomer. We are really wrangling over the future course of our society. With uncertainty, and disagreement over values, society will move slowly and pursue no single policy. Attempts to push faster and harder in one direction will only increase the amount of social instability. Visions of the future are valuable; they just cannot be guaranteed.

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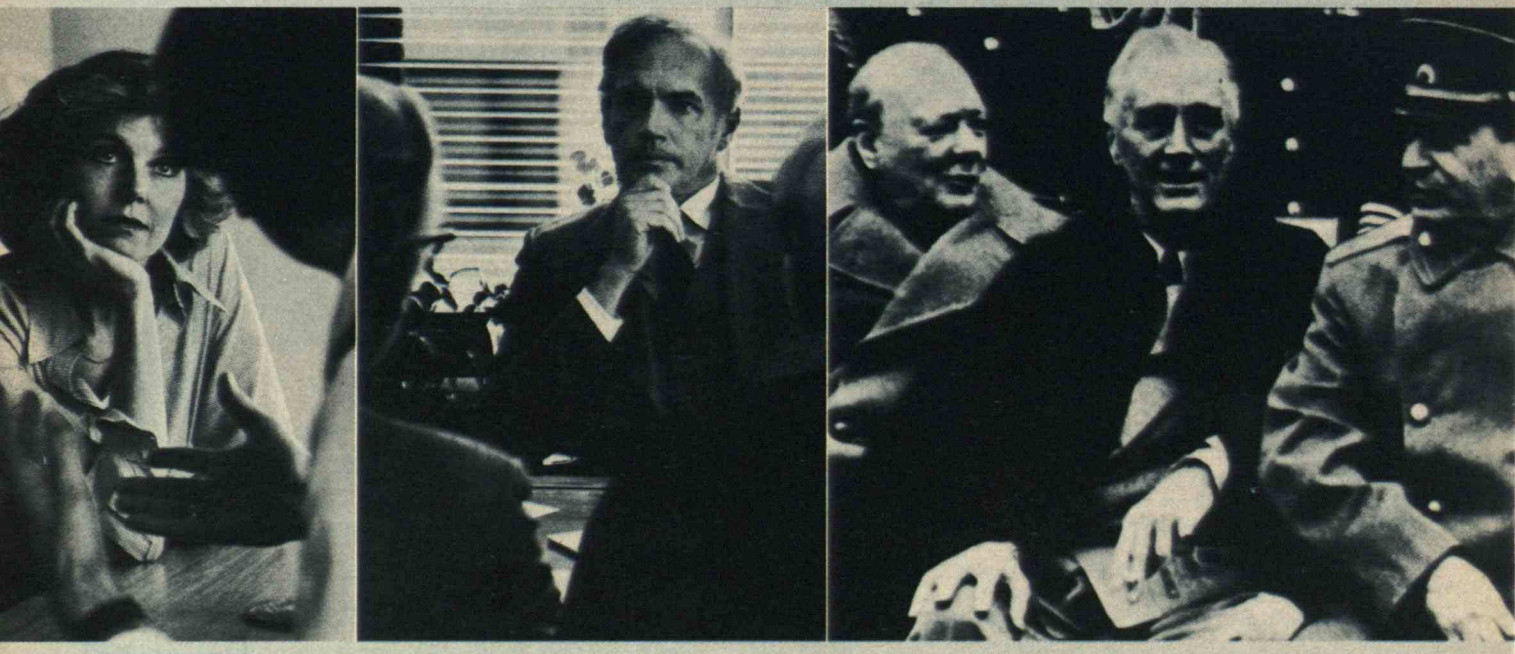

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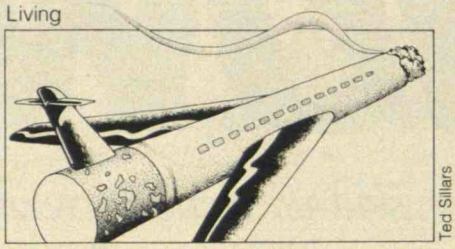


Ted Sillars

Flying and Fear of Smoking

To nonsmokers who fly scheduled airlines: don't rely on the designated "no smoking" areas aboard aircraft for oases of fresh air. The plumes of smoke from cigarettes, cigars, and pipes will seek you out wherever you sit, thanks to the inherently democratic design of airborne ventilation systems: share and share alike — tobacco smoke as well as "conditioned" air.

No matter what the signs say, the air in nonsmoking sections is no freer of particulates from tobacco smoke than is the air anywhere else on an airliner, found John Walker, senior scientist for Energy Resources Company in Cambridge, Mass. Using equipment loaned by the Harvard School of Public Health, he carefully monitored the air aboard a "half-full" Boeing 707 flight from Boston to Los Angeles with one stopover in Dallas-Fort Worth. The detector device he used measures the optical density of the "cloud" of water vapor that condenses on airborne particles. Measured particle diameters varied from 0.01 to 0.1 micrometer.

His log of the 10:00 flight from Logan Airport in Boston includes the following observations:

☐ The number of particles in the aircraft ranged from 14,000 to 150,000 per cubic centimeter during the flight.

☐ While the plane was awaiting takeoff from Boston the interchange of air with the smokey pre-boarding lounge produced a particulate count of 150,000 per cubic centimeter in the aircraft.

☐ One hour into the flight the particle count in the nonsmoking section plummeted to 18,000 per cubic centimeter; at this time the smoking section count was 50,000 particles per cubic centimeter.

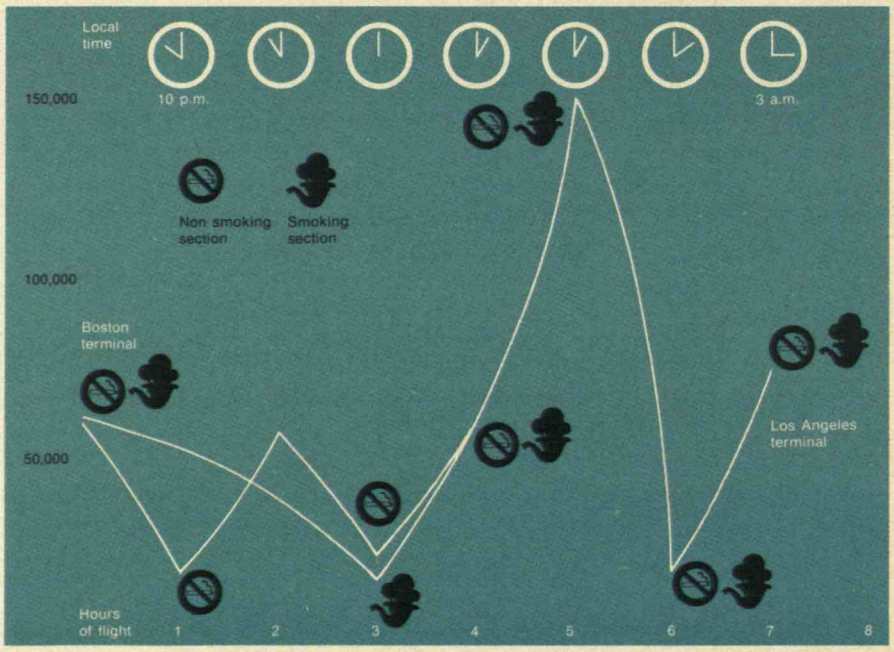
☐ But after another hour the particulate level in the nonsmoking section "surpassed the smokers' section," reported Mr. Walker.

☐ Two hours later most passengers were asleep, and particulate levels dropped to their lowest point of 14,000 per cubic centimeter.

☐ Smoking recommenced with vigor one hour later as the 707 picked up fresh passengers at Dallas-Fort Worth (1 a.m. local time). Particulate readings soared to 150,000 per cubic centimenter "for smokers and nonsmokers alike," observed Mr. Walker.

☐ One hour later it was naptime again; readings dropped to 19,000 particles per cubic centimeter throughout the passenger cabin.

☐ Eight hours after leaving Boston, the 707 began its descent into Los Angeles. Sleepers wakened; some lit up in earnest.



A record of particulates in the passenger cabin air of a Boeing 707 flying from Boston to Los Angeles. Note that particulate counts in the nonsmoking section actually surpass those in the smoking section for several hours during the flight. (*Data: John Walker*)

Particulate readings in both smoking and nonsmoking sections climbed to 72,000. (In comparison, Los Angeles terminal air was host to only 29,000 particles per cubic centimeter during those wee hours.)

It's easy to be cynical — and perturbed — about Mr. Walker's findings, particularly because it's technologically trivial to efficiently filter the air in an airliner or to separate entirely the ventilation systems in smoking and nonsmoking sections. Meanwhile, current efforts to achieve localized high air quality aboard airliners are more accurately characterized as dictatorial rather than democratic: there's no way out for nonsmokers at 30,000 feet. — *L.A.P.* □

High Technology In the Food Chain

Fifty years ago the well-equipped grocer had a stubby pencil, a pile of paper bags, and maybe an adding machine on the counter near the front of the store. Today an automated check-out station in a supermarket can cost $100,000.

What was once a simple building filled with shelves and racks is now a million-dollar automated food warehouse.

The U.S. food supply system, already the most capital- and technology-intensive in the world, is headed for more of the same, says Merritt L. Kastens, editor of *Food Industry Futures*. But with a difference, since the invasion of technology in the future will proceed in two very different ways:

□ Trends of the past 50 years will continue, with more labor replaced by more machines that streamline existing ways of producing, processing, and transporting food. This means new farm machines (complex tractors now sold for farming cost up to $100,000), more automation, and greater efficiency (the food industry uses very little energy at temperatures above 350° F., and lots of waste heat discharged from industrial processes at higher temperatures than this will soon be used for food processing).

□ There will be a radical departure from the past by new entrants in the field who concentrate on wholly new processes and systems. "You don't worry about processing bacon without nitrites," Mr. Kastens explains; "you engineer a synthetic bacon with designed-in shelf life. . . . You no longer catch fish; you 'manufacture' them in controlled-husbandry systems."

Speaking to the American section of the Société de Chimie Industrielle in New York early this year, Mr. Kastens attributed this new thrust of technology into the food supply system to the entry of a whole new class of high-technology companies accustomed to investing big stakes in complex systems. Among the names are Proctor and Gamble, General Electric, Merck, Bechtel, McDonnell-Douglas, Union Carbide, Corning Glass. . . .

"The heavy technology people with the deep pockets are lining up . . . to exploit this new era of food production," Mr. Kastens said. "The one thing you know about the future is that it will be radically different from the past." — *J.M.* □

Automobiles

Molded fiberglass reinforced polyester resin wheel. The 13.4-pound unit is about 12 pounds lighter than a steel wheel. The lighter unsprung weight means better handling, economy, and ease of wheel balancing. *(Photo: Chrysler)*

Automaking in the 1980s

There's good news and bad coming from U.S. automakers today. The good news, they say, is that the nation's love affair with the automobile is far from over; the bad news is that love affairs have their ups and downs.

Historically, the industry has been able to almost completely ignore the issue of fuel economy; the U.S. has a tradition of cheap and plentiful fuel. But that's changed, and the motoring public has sent out clear signals of unhappiness, evidenced by ominously large inventories of unsold big cars and piles of back orders on small cars.

"Our customers are our number one taskmaster," Elliott "Pete" Estes, president of General Motors, told a management briefing seminar for auto industry executives held by the University of Michigan in August. And, he warned, even the "slickest advertising won't sell [big] cars. . . . our customers are aware of the fact that there is a serious energy problem." The industry, he admonished, "must stop talking and start working on the problems."

In addition to fuel economy, the problems to which Mr. Estes referred include lower emissions and more robust, rust- and damage-resistant automobiles and light trucks. However, he said, industry movement in these directions is a "response to the market, not to Washington."

Nevertheless, of the $4 billion of capital General Motors sank into production costs last year, "about $1 billion" was applied specifically to meet federal regulatory mandates, he said. And designers and engineers throughout the auto industry are wrestling creatively with a number of approaches to keeping ahead of the regulators' demands.

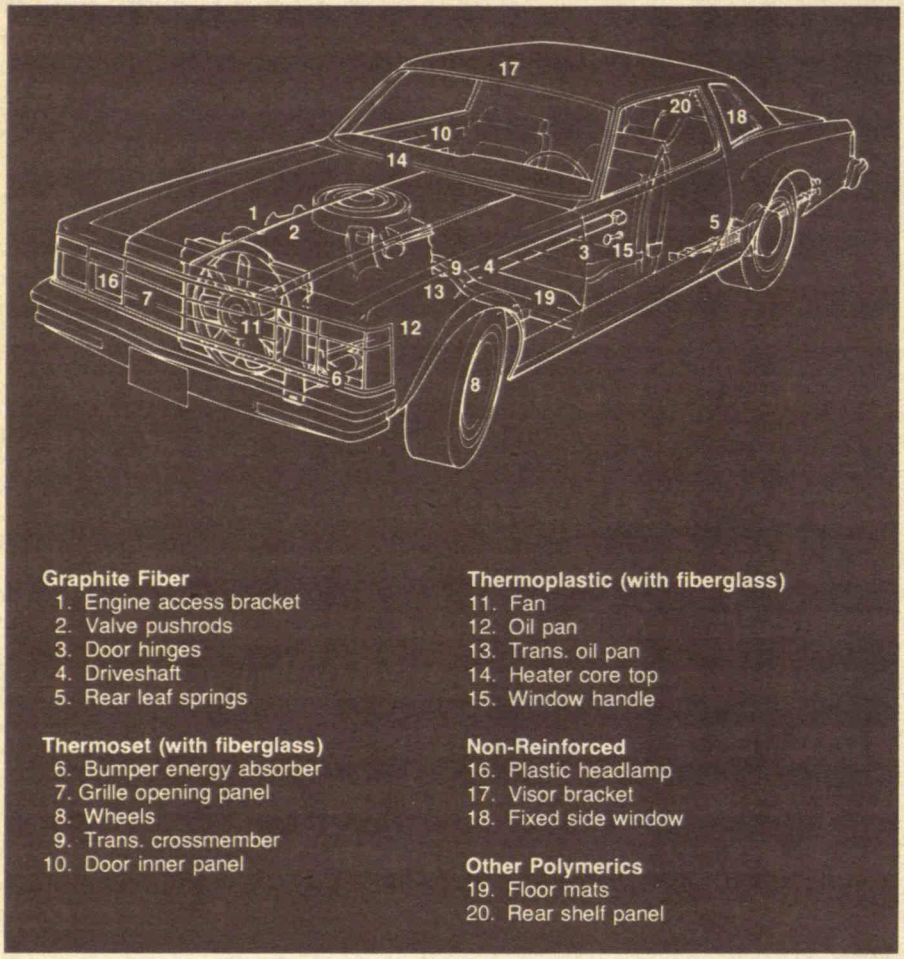
For example, the corporate average fuel economy (C.A.F.E.) requirement enacted by Congress — 27.5 miles per gallon in the 1985 model year — has led to experiments with new structural materials in a quest for lighter weight coupled with greater strength and rust-resistance. Aluminum, high-strength "low-alloy" steels, various advanced composite materials, reinforced plastics and nylon: "Each material has a right place in the vehicle," said Aaron D. Rosenstein, materials supervisor for Chrysler. These expensive materials will be used in frame members, bumpers, body panels, splash shields, wheels, and various engine parts. On display from Chrysler at the seminar were engine and transmission oil pans made of "STX" epoxy composite, a rear-axle leaf spring of fiberglass-reinforced plastic, and graphite fiber composite door hinges.

Weight-shedding is only one of the lengths to which the automakers are going to keep the "love affair" alive. Trends to 1985 and beyond were plumbed in the University of Michigan's *Delphi* Study, which involved circulating a questionnaire among several hundred of the industry's top management. Some predictions from the composite analysis were offered by Associate Professor David Cole, director of automotive studies at the University:

□ In 1985 gasoline and diesel fuel will sell for about $2.50 (1978 dollars) per gallon.

□ In 1985 half of our cars will have front-wheel drive; average car weight will be 3,000 pounds; and light trucks, 4,000 pounds.

Parts of the 1980s automobile destined for polymerization. Plastic parts will save weight: the total savings of these parts is about 160 pounds, according to Chrysler Corp. But questions of repair outside the factory and of recycling automobile parts are still begging for answers. (Art: Chrysler)



Graphite Fiber
1. Engine access bracket
2. Valve pushrods
3. Door hinges
4. Driveshaft
5. Rear leaf springs

Thermoset (with fiberglass)
6. Bumper energy absorber
7. Grille opening panel
8. Wheels
9. Trans. crossmember
10. Door inner panel

Thermoplastic (with fiberglass)
11. Fan
12. Oil pan
13. Trans. oil pan
14. Heater core top
15. Window handle

Non-Reinforced
16. Plastic headlamp
17. Visor bracket
18. Fixed side window

Other Polymerics
19. Floor mats
20. Rear shelf panel

☐ In 1985, 50 per cent of U.S. cars will be built with four-cylinder engines; 30 per cent will have V-6s; 10 per cent V-8s; 10 per cent in-line sixes; about 15 per cent will be diesels.

☐ Five years later, to meet the expected C.A.F.E. requirement for 1990 of 30 miles per gallon, about 72 per cent of U.S.-made cars will have four-cylinder motors and 25 per cent will have V-6s. The V-8 will be gone and the in-line six-cylinder engine will be used in only 5 per cent of our cars. About one out of four autos will have diesel engines. Snappy performance will be preserved by the use of fuel injection and turbochargers, merely a sampling of automakers' "big bag of tricks," said Professor Cole.

The changes will be so difficult and expensive that some makers may have trouble keeping up with the demands of the market and the challenge of competition. Said John Schnapp, vice-president of Harbridge House, Inc., of Boston, "It's hard to think of a corporation as big as Chrysler disappearing from the landscape, but the prescription is not yet in sight." His prediction: "Chrysler won't disappear, but its shape in 1985 won't be the same as now."

What about alternative fuels? The advent of "synfuels" doesn't worry Elliott Estes, who remarked that gasoline-like distillates from coal, for example, would require "no changes in our product." Methanol, but not ethanol, could be a motor fuel of the future. Theodore Wagner, manager of product and environmental research at Amoco Oil Co., calculates the cost of producing enough methanol to yield one million B.t.u.s to be about $9; ethanol, about $25. In comparison, today $6 buys enough gasoline to yield that amount of heat. Mr. Wagner, who worked out the wholesale prices of the two alcohols when gasoline was wholesaling for 69 cents per gallon, determined that methanol would cost retailers about 50 cents per gallon if "local efforts" to distill wood, straw, and garbage got underway. Ethanol, largely produced from sugar-cane, would wholesale for a stiff $1.90 and require a "significant farming effort," he pointed out. Beyond consideration of cost, he said, is a chemical truth: the heat content of a volume of alcohol is only about half that of gasoline, and significantly larger fuel tanks would be needed in alcohol-fueled cars.

Enter the electric vehicle (EV). Elliott Estes foresees for the "mid–'80s" a small two-seater EV capable of traveling 100 miles at 50 miles per hour on one charge of its zinc–nickel-oxide batteries. For now, he said, range is "one of our problems."

Does the time required for developing and tooling-up for major new products at General Motors presage the appearance of that EV by 1984? The project to produce the economic "X-car" — the most expensive single development effort ever undertaken by the corporation — got underway in 1974, Robert Eaton, Oldsmobile's assistant chief engineer, told the seminar. The first refined result of that effort — the Chevrolet Citation — came on the market in mid–1979 (as a "1980" model to favorably impact General Motors' C.A.F.E. figure for 1980). That five-year lead time is food for thought.

The public will perceive the sticker prices for the new cars to be high, warned Professor Thomas Juster, director of the Institute for Social Research at the University of Michigan. That view, he said, is consistent with recent polls that show consumers feel "pessimistic about the world" in general. But the real prices of cars and fuel declined during the 1950s and 1960s and he predicted that upcoming auto price increases will roughly parallel the Consumer Price Index.

Certainly the bottom line for the auto industry will not be bleak. "Personal mobility is an important part of our lives," Lloyd Reuss, Chevrolet's director of engineering told the seminar. Between nine and ten million people "expect to buy a new car in one year's time," said Professor Juster.

"However, the public is telling us that it is ready for a quantum step in its product acceptance," observed Gene Bordinat, vice-president in charge of design at Ford Motor Co. Mr. Bordinat's personal dream car is a 1,200–pound, 50– to 60–miles-per-gallon, two-seater powered by a small engine like "an aluminum motorcycle engine," and with a "friendly" albeit aerodynamic look.

"Will Ford be able to produce your dream car?" asked someone in the audience. (Each one-tenth mile per gallon improvement in Ford's C.A.F.E. costs the firm $100 million.) Yes, replied Mr. Bordinat, adding, "We know a lot of things you don't know." — *L.A.P.* ☐

The first "near term" electric vehicle prototype, developed for the U.S. Dept. of Energy (D.O.E.) by General Electric Corp., Chrysler Corp., Globe-Union Inc., and Modern Engineering Services, Inc. ETV-1 (for Electric Test Vehicle) can seat four passengers and has additional space for cargo behind the rear seat. Its 18 improved lead-acid propulsion batteries, rated at 108 volts and 174 ampere-hours, can be recharged 500 times from a deeply discharged state — about 25 per cent better than conventional batteries. The DC motor, rated at 31 kilowatts (41 horsepower) peak and 15 kilowatts (20 horsepower) continuous output, drives the front wheels through a double-reduction, chain-drive transmission.

The 3,320-pound vehicle can carry two passengers for 122 miles at a constant speed of 35 miles per hour, 102 miles at a steady 45 miles per hour, and 75 miles following the Society of Automotive Engineers' J227a driving cycle, which includes stops, starts, and a top cruising speed of 45 miles per hour.

A single 12-volt battery powers its accessories, and interior warmth can be provided by a gasoline-fueled heater.

R & D for ETV-1 cost about $7 million, including $500,000 for its construction. But the sticker price will be more reasonable.

In quantities of 100,000, says the D.O.E., "the consumer price goal is $6,400 in 1979 dollars." (Photo: D.O.E.)

What to Do With an Old 1985 Car?

It's a time of unprecedented change in the U.S. auto industry, dictated very largely by government and consumer demand for increased economy; the Energy Conservation Act of 1975, mandating a 1985 corporate average fuel efficiency of 27.5 miles per gallon, started a scramble which has yet to run its course.

Because the correlation between vehicle weight and economy is almost unyielding, Detroit's quest for improved gasoline mileage really represents a campaign against weight. It affects both the amounts and kinds of materials in automobiles — and the ways in which they are used. And it will also affect the ways in which worn-out automobiles of the future can be recycled — though very few people think about that aspect of today's and tomorrow's shiny new vehicles.

By 1985, says Professor Michael B. Bever of M.I.T., a large fraction of the plain carbon steels now in automobiles will be replaced by lesser quantities of high-strength steels — and in some cases by aluminum alloys. There will be small reductions in the use of cast iron and stainless steels, but these will be dwarfed in importance by the growing use of plastics, probably including composites of resins reinforced by glass or graphite fibers and hybrid panels of steel, aluminum, and plastic.

By definition, smaller cars will contain less materials. Shredder operators will find revenues from steel scrap thinner. Futhermore, the steel they recover may contain some new alloying elements — notably nickel and molybdenum — which are undesirable in ferrous scrap; indeed, the increase in these and other residual alloying materials in scrap "will be one of the most severe adverse effects" of the changes he foresees by 1985, says Professor Bever.

There will be more aluminum in 1985 cars than in current models, and — like tomorrow's steels — there will be a greater variety of alloying elements. Some, like those in steel, will be hard to deal with.

But it is from the prospective increased use of plastics that will stem major recycling problems. The presence of reinforcing fibers will complicate an already complicated process. The recyclability of hybrid panels is at present unpredictable, since it would depend on the kind of bonding used in their manufacture. "There is no published indication that this has been recognized as a problem," says Professor Bever. Indeed, he says, "expansion in the use of plastics will create problems for which no adequate solutions are at present available." — *J.M.* □

Peat to Heat, Light, and Feed the World

Peat, vegetation just started on the road from biomass to coal, is mostly resented by those in the United States whose land is covered with it. But that peat bog in your lower forty may soon come into its own as a source of fuel or fertilizer.

Already one-third of the thermally generated electric power in Ireland comes from peat, and large-scale harvesting and dewatering of peat is practiced in many northern European countries. Not so in the U.S., despite the fact that we have the second largest peat resource in the world, containing some 1,440 quadrillion British thermal units of energy, equivalent to that in 240 billion barrels of oil.

The Institute of Gas Technology in Chicago would have us end our neglect. After several years of intensive study, engineers at the I.G.T. and the Department of Energy conclude that peat is superior to coal for conversion to methane. Some 26 per cent of the carbon in peat can be converted into methane in a hydrogasification process, while lignite (low-grade coal) under the same conditions gives up only 8 per cent of its carbon.

Meanwhile, the first U.S. experiment in producing peat for fuel is now taking place at First Colony Farms of North Carolina, which holds a resource estimated at 400 million tons, enough to fuel a 1,600-megawatt power plant for nearly 40 years.

Most peat contains about 95 per cent (by weight) water — more than can be evaporated by the energy in the peat itself. Peat intended for fuel is usually dried by the sun directly on the site of cutting, the goal being to reduce the moisture content to between 35 and 45 per cent. The Farms is now experimenting with cutting and drying processes to see if enough peat can be harvested and prepared during the warm months of the year to fuel year-around operation of an electric generating plant.

Those who would cut and burn our peat may soon be challenged by those who would enrich and farm it. Alexander Szalay of the Hungarian Institute of Nuclear Research has discovered why peat soils, despite being rich in humus, are so barren of plants — and how they can be made to yield verdant crops. The problem, he said in a paper for the American Chemical Society, is that peat-grown plants are deficient in manganese and copper. Those

elements, though present in peat soils, are made insoluble by humic acids also present; and when more manganese and copper are added in fertilizers, these nutrients, too, are quickly tied up by the excess of humic acid. Dr. Szalay's solution — not easy to develop, he says — is a spray from which peat-grown plants can absorb the manganese and copper they need. Peat land could thus be rendered highly productive, Dr. Szalay said, and he believes this underutilized agricultural resource may now substantially increase world food production. — *J.M.* □

The High Cost of a Nuclear Moratorium

What would happen to the U.S. coal industry and the environment in which it operates if today's *de facto* moratorium on building new nuclear power plants becomes a permanent moratorium between now and the year 2000?

The answer in a nutshell was generated from a computer model of energy supply and demand at the M.I.T. Energy Laboratory. Annual coal production would reach just over 2.4 billion tons in that year, assuming coal, oil, solar, and other energy sources are mixed to meet the energy demands of utilities and industry at lowest possible cost.

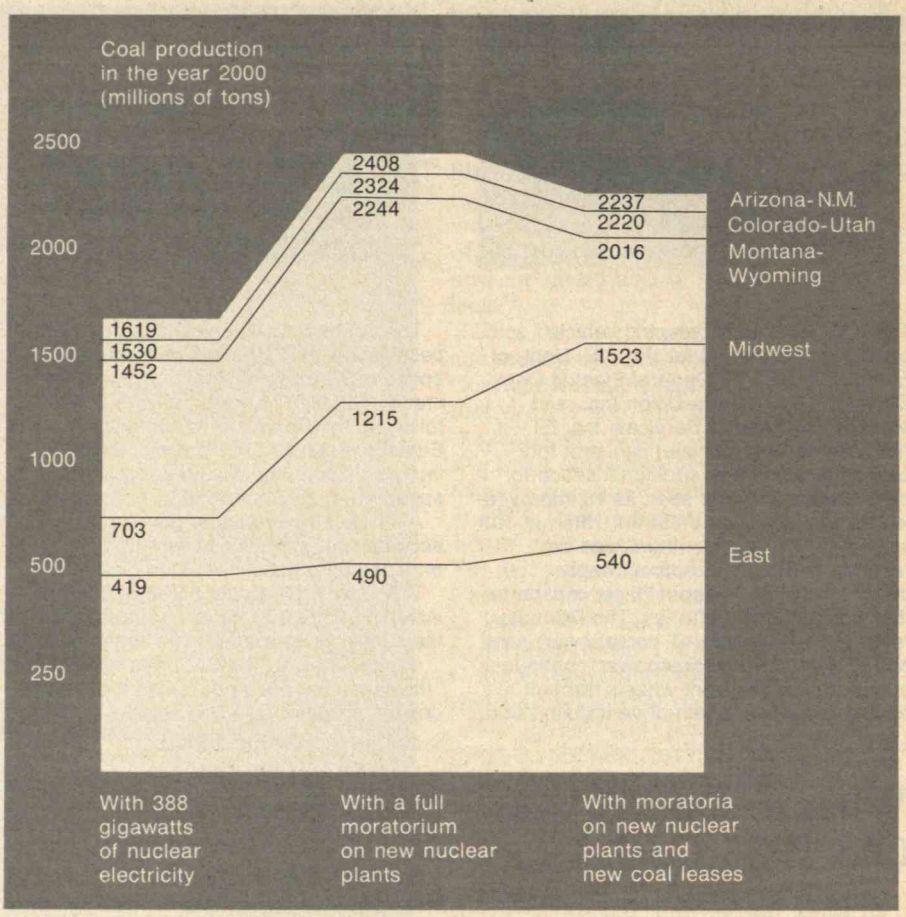
With construction of about 300 new nuclear plants by the year 2000 coal use would increase only to 1.6 billion tons.

The model predicts that the cost of electricity in the year 2000 would be 12 per cent higher under a nuclear moratorium than without one.

To put his figures in perspective, Professor Martin B. Zimmerman of the Sloan School of Management explains: under a full nuclear moratorium, total coal production in the midwest and Montana-Wyoming fields in the year 2000 would have to be roughly 2.5 times that in all the U.S. today. The effect of such an increase clearly would have significant environmental implications.

If, as Professor Zimmerman suspects, concern with these implications should lead to a moratorium on the leasing of new coal mines on government land in the west, there would be sharply increasing pressure on privately-owned coal in the midwest and the Colorado-Utah area. The cost of coal would rise, and the model shows that by the year 2000 the price of electricity would be at least 17 per cent higher than under the no-moratoria scenario. — *J.M.* □

Current U.S. coal production is 700 million tons a year. Without a moratorium on nuclear power plants, we'll need 1.6 billion tons in the year 2000 to meet at lowest possible cost the energy demands of utilities and industry. If no nuclear capacity is added, that figure will rise to 2.4 billion tons, with large amounts coming from the midwest and Montana-Wyoming areas. And if the severe environmental implications for these areas lead to a moratorium on new government leasing, the pressure will be transferred to coal on private lands in the midwest and Colorado-Utah areas. (*Data: M.I.T. Energy Laboratory*)



Innovation

How the Feds Will Rescue Innovation

Can the U.S. capitalize on technology such as robotics to restore its rate of productivity increase, making more goods with less labor, capital and materials?

President Jimmy Carter made that question a matter of highest priority for his presidential science adviser, Frank Press. Professor Press in turn asked Jordan J. Baruch, Assistant Secretary of Commerce for Science and Technology, to recommend how U.S. innovation can increase productivity and sharpen our competitive position in world markets.

Among Dr. Baruch's recommendations:

□ Reduce regulatory uncertainty. The rate of innovation is presumably proportional to the anticipated rate of return on investments in innovation, and uncertainty of all kinds jeopardizes that rate of return. So Dr. Baruch has recommended that the government establish and commit itself to a calendar for regulatory change.

□ Increase tax incentives. The majority of analysts agree that most innovation comes from small firms, not large ones. So Dr. Baruch wants special tax advantages for small firms — perhaps a graduated income tax with a rate proportional to company size — which would encourage investors to give small firms the venture capital they need.

□ Reorganize the patent files. Patents are now organized by the Patent Office for the convenience of lawyers, not of innovative engineers and inventors, says Dr. Baruch. He would help make patent information more accessible to would-be entrepreneurs.

□ Emphasize cooperation on generic technology. A generic breakthrough is one that opens the way for many new innovations. One of Dr. Baruch's examples was the system for moving tape through a recorder, which was the key to countless new devices for recording sounds and pictures. He hopes to encourage companies who would otherwise compete to join forces in researching such productive generic breakthroughs.

Join The Union... Or Else.

Sammy Kirkland spends most of his time these days on a hog farm, away from his home in Ft. Myers, Fla. He doesn't answer his mail or the telephone.

He's kept a low profile ever since that terrifying day in May 1971 when a union mob nearly killed him on an excavation job, breaking three of his ribs, putting steel shavings in his eyes and threatening to cut off his arms.

Why were they out to get him? Because he refused to join a local union. Sammy Kirkland's life has been altered, forever, because he refused to abandon his right to work to union goons.

Other lives have been changed too. Four of the union agents responsible for the vicious attack were given five-year jail sentences. Kirkland also filed a damage suit against the local and international unions.

In early 1976, union officials agreed to a $165,000 out-of-court settlement, one of the largest ever obtained in a union violence case. But as Kirkland's attorney provided by the National Right to Work Legal Defense Foundation said, "No amount of money can compensate him for the damage that's been done."

Sammy Kirkland's case, shocking as it is, is not an isolated one. Herbert McGruther of Lake City, Fla., was fired from his construction job in 1975 because he refused to join another local of the same union.

McGruther was subjected to a different kind of intimidation. A union agent prominently displayed a large pistol in his belt while demanding that McGruther pay a union initiation fee and dues.

McGruther, with the support of the National Right to Work Legal Defense Foundation, has filed suit, charging the union with violating his rights and asking for punitive damages.

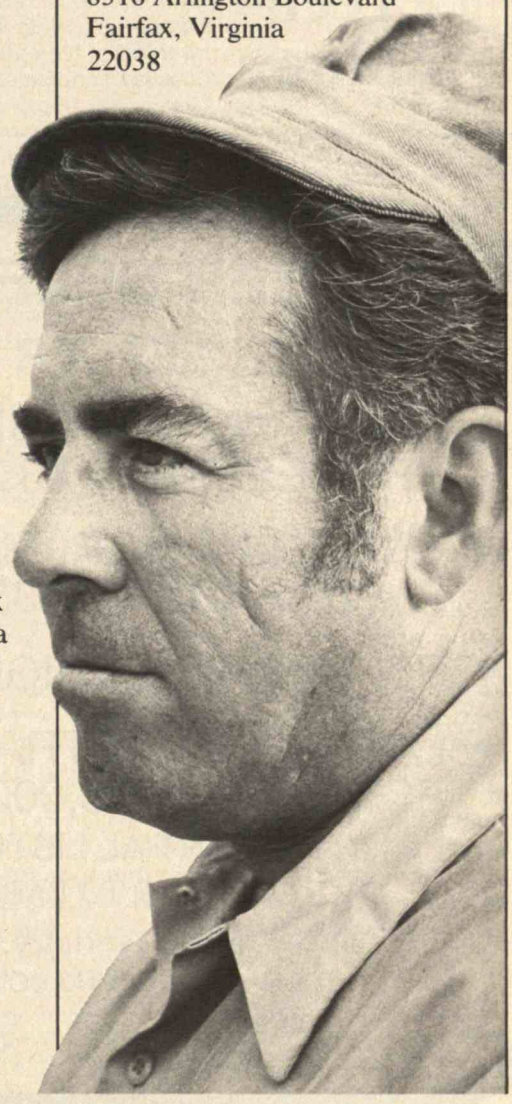
Sammy Kirkland and Herbert McGruther were fortunate. They found help. But how many other Kirklands and McGruthers in America need similar help?

The National Right to Work Legal Defense Foundation is a publicly supported charitable institution that provides free legal aid to employees whose rights have been violated because of compulsory unionism. The Foundation is currently assisting workers in more than 50 cases across the country.

If you want to help Herbert McGruther, and all the other McGruthers and Kirklands in our society, we'd like to hear from you.

For more information on how you can help workers like Sammy Kirkland and Herbert McGruther, write:

The National Right to Work
Legal Defense Foundation
Suite 610
8316 Arlington Boulevard
Fairfax, Virginia
22038



☐ Reform the patent system. As it stands now, patent protection has to be established before a new product can be tested for compliance with government regulations. The result is that as much as half of the 17 years' patent protection can be consumed during testing, before a product even reaches the market. Dr. Baruch would change that.

☐ Try to foresee the implications of innovations. Many innovations fail in development because entrepreneurs needlessly fear their negative effects on existing products or procedures; if such effects could be predicted, thinks Dr. Baruch, innovations could be better managed.

☐ Increase U.S. education for innovation. No engineering school curriculum contains a class in how to innovate, nor does Dr. Baruch propose attempting that subject. But he thinks emphasis in engineering schools on the uses of science as well as on science itself would produce engineers who are better as innovators.

Some steps that might stimulate innovation — according to conventional wisdom among engineers — are *not* recommended, Dr. Baruch said. For example, he does not urge "turning back the clock on regulation," he said, nor does he urge lower constraints against inflation in order to free venture capital or reduce the rate of return required of unconventional new investments.

(But Robert A. Charpie, President of Cabot Corp., finds high inflation and interest rates a serious constraint on innovation and entrepreneurship. When inflation reaches 10 per cent, a 15 per cent return on a risky investment is not enough. The return would have to approach 25 per cent, he said, and it's the rare innovation that can promise so much.)

Most of all, Dr. Baruch says, he sought to structure his recommendations so that they focus on incentives for private industry to increase productivity in its own "diligent self-interest."

Among the technology community, Dr. Baruch's proposals seem welcome enough. Joseph F. Coates of the Office of Technology Assessment wonders if Dr. Baruch plans to evaluate his recommendations by monitoring future productivity and innovation trends (Dr. Baruch will do so); and if the plans should include offsets for the popular trend of "resistance to large technology." To the latter, Dr. Baruch responds that innovative technology can be either "large" or "small," and he thinks that some of the most productive future innovations will be those which reduce set-up cost and economic lot size. — *J.M.* ☐

Cycles of Innovation: Golden Age Ahead?

Behind the 50-year cycle of economic activity called the Kondratieff wave lies a changing climate for innovation which should be understood by every corporation's planners and every innovator who seeks to profit from an invention, says Jay W. Forrester, Germeshausen Professor in the Sloan School of Management at M.I.T.

A national economic model being assembled by Professor Forrester and his colleagues at M.I.T. has revealed the significance of the Kondratieff cycle, a pattern of economic change which includes a decade of depression, 30 years of active capital investment, and ten years of economic uncertainty while growth forces subside (*see "Changing Economic Patterns" by Jay W. Forrester, Aug./Sept., 1978, pp. 46-53*). According to this analysis, the time is now ripe for the innovative new technologies on which the industries of the next century will be based.

The speed and kind of technological change to which innovators can contribute are deeply affected by the cycle, Professor Forrester told an M.I.T. symposium in London late last year. It works this way, he explained:

Each major expansion within the long wave develops on the basis of "a highly integrated and mutually supporting combination of technologies." These technologies gradually become entrenched. When mature technology is in the saddle, acceptable innovations are those which represent only incremental change; fundamental innovations which threaten accepted patterns are likely to be unwelcome. A period of decreasing prosperity ensues, characterized by low corporate profits and high social costs. Then finally, amidst depression, those who managed the obsolete technologies relinquish control, and 30 years of accumulated new ideas suddenly find a receptive audience of investors in new products and processes.

If Professor Forrester is right, we're now at the end of an era, with matured technologies still ruling the roost but with "a small but gradually increasing number of people developing the radical new mix of technology to replace that which the first group is exploiting to obsolescence." — *J.M.* □

Last Line

Product Liability: Excellence by Edict or Effort?

There's a lot of risk attached to putting out radically new lines of cars and trucks, and much of it has nothing to do with sales.

Implicit in the rapidity and depth of change through which U.S. automakers are meeting federal regulations and the demands of the market is the creation of serious legal risk, should the design or quality of any of those new vehicles be the cause of an accident. Such risk is called product liability, and it can ruin companies.

Auto companies are legally liable for "engineering malpractice" in the quality of design, manufacturing, materials, and assembly of their products, says Charles Babcock, a General Motors Corp. attorney. And they also must warn users of the dangers inherent in their products, he explained in August to the University of Michigan's management briefing seminar for auto company executives.

But he does not intend to expose himself and his industry to the "violent enthusiasm" with which consumers are now filing product liability suits against the big auto companies, said Mr. Babcock. They're doing it, he charged, because there is "every incentive to sue and no disincentive not to:"

- □ It costs only about $30 to file a complaint in court.
- □ A plaintiff's lawyer stands to lose nothing but time in the event a suit is lost, but to win between one-third and one-half of the settlement in case of victory.
- □ Countersuits are almost never lodged, even by winning defendants.
- □ Plaintiffs have the valuable right of examining the internal documents of the defending company, a privilege granted in the legal doctrine of *discovery*.

Discovery gave rise to "the *New York Times* rule" at General Motors during the 1960s. It goes like this, according to Mr. Babcock: "If an internal document can be reprinted in full on the front page of the *New York Times*, it's probably all right."

Discovery also gives a defendant the right to see the plaintiff's evidence before trial. The potential for out-of-court settlement of valid claims is thus enhanced. But discovery privileges have been abused by plaintiffs, "who may not know you've done something wrong but hope you have," warned Mr. Babcock. "There is no document in your company anywhere that is absolutely protected from revelation to an outside hostile third party," he said.

"In no country anywhere in the civilized world does that system exist, except in the U.S.," Mr. Babcock told the seminar.

Mr. Babcock advised his colleagues in the industry to shun the courtroom wherever possible. Court itself can be a "circus" in which "housewives and barbers" and other "nontechnical people" make the findings and set the damages, he said. And some of the "expert testimony" on which those findings are based is "beneath contempt," he added.

Furthermore, the publicity accompanying a trial may be as damaging as the legal findings themselves. Indeed, whatever the outcome, it's almost certain that internal secrets will be publicized and reputations jeopardized in any major trial.

Don't make the mistake of letting insurance companies handle such suits, Mr. Babcock advised. They have a "compensation or settlement mentality" and aren't interested in defending their clients in court.

General Motors' policy is to take to court "only those cases where we are absolutely and totally convinced that our product was not defective and did not cause the injuries. Where we think it did cause the injury, we have every incentive to settle, if we can. . . . The goal is to dispose of what I might call the 'guilty' cases as soon as possible" and fight with "ever-audacious" fervor those lawsuits that can be won.

Product liability lawsuits won't "go away," Mr. Babcock warned the automakers, and when General Motors goes to court with one, it wants the jury to find for the corporation so firmly that they're "climbing out of that jury box looking for order blanks." — *L.A.P.* □

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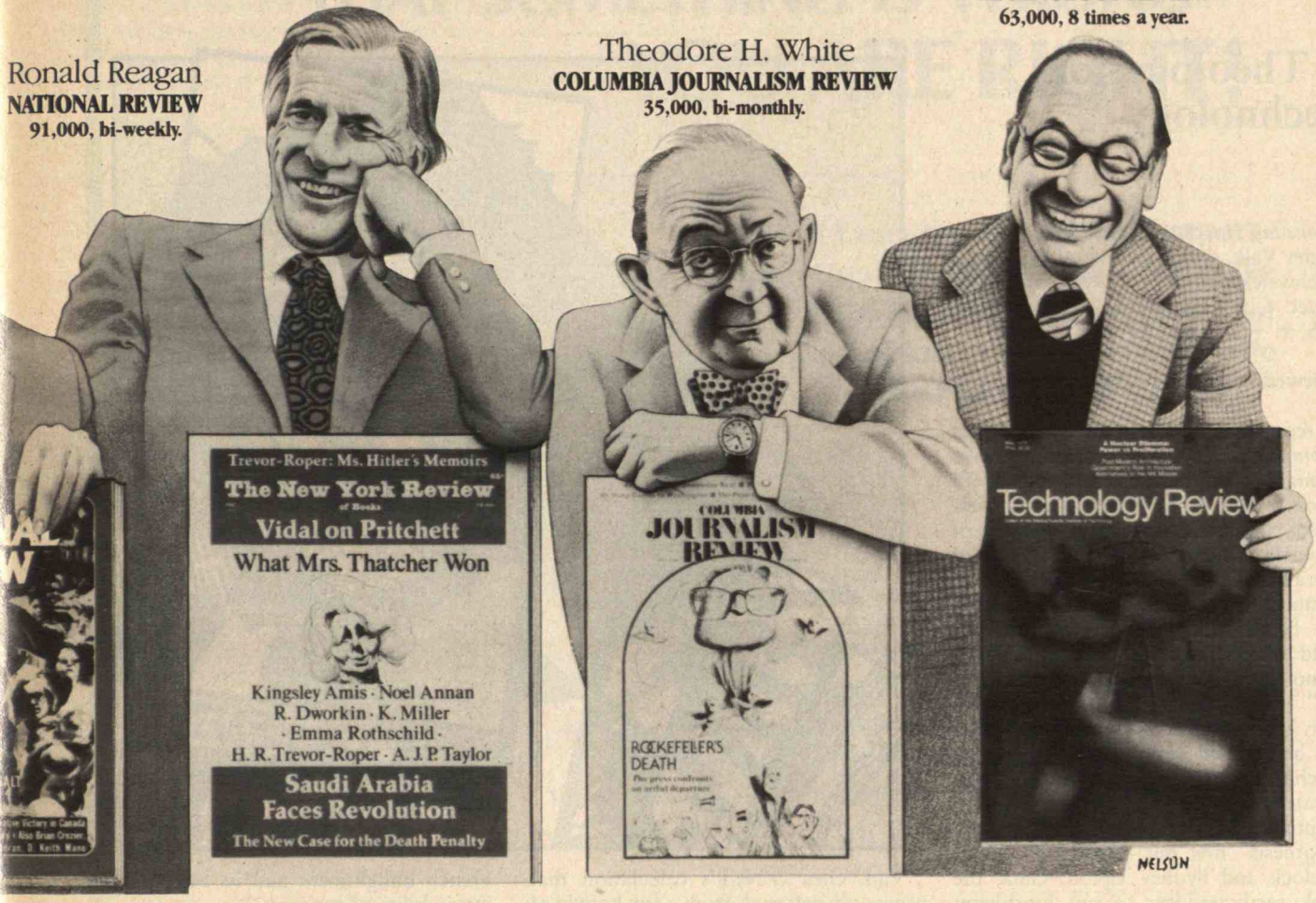

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A Theology for Technology

Doomsday Has Been Cancelled
J. Peter Vajk, with a Foreword by Russell L. Schweickhart
Culver City, California: Peace Press, 1978, xi + 227 pp.; $7.95

Reviewed by Frank P. Davidson

Renée Klein

In a recent article inaugurating the journal *Technology in Society*, Harvey Brooks summarized a debate destined to be with us for a long time. "There are the pessimists, who believe that the salvation of the world is impossible, largely because of human addiction to science and technology. Then there are the optimists, who believe that the salvation of the world is inevitable because science and technology will always come to our rescue."

Dr. Vajk leaves us in no doubt at all: he is to be counted among the optimists. In this charmingly written and attractively illustrated book, the reader is beguiled into accepting a modernist myth, "the Gaia Hypothesis" first put forward by James Lovelock and Sydney Upton. Gaia, the Greek earth goddess, is our biosphere; humanity represents a "central nervous system" for Gaia who, thanks to the memory and management skills of mankind, will be able to reproduce herself in endlessly proliferating space colonies.

Dr. Vajk is a theoretical physicist and a Californian. A confessed disciple of Princeton's Professor Gerard K. O'Neill, his *Doomsday Has Been Cancelled* should really be read in tandem with O'Neill's *The High Frontier*, which has become a basic text for growing numbers of enthusiasts for "brave new worlds" out yonder. But it would be wrong to dismiss Peter Vajk's thesis as a "science fiction" addition to utopian literature or as an extreme essay in futurological speculation.

Peter Vajk has written a coherent and closely argued exhortation to join in a new chapter of the human story. Although *Limits to Growth* is excoriated, Dr. Vajk has basically substituted a new assumption for the "closed system" presupposed by the early Club of Rome studies: with system boundaries spectacularly altered, world *problems* such as overpopulation, pollution, and energy shortages simply dissolve as Cosmic Man decongests the earth and roams the Universe.

Vajk cites O'Neill's calculation that, using only materials from a few known asteroids, space colonies could have a total land area "3,000 times the total land area of the planet Earth." The first colonies, apparently, will be base camps for the construction of orbiting solar power satellites. He admits that the "research and development" for a viable solar power satellite program will cost "tens of billions of dollars," but space manufacturing facilities using zero gravity, and improved communication satellite structures, are among the other possible "clients" for the colonists should the solar power satellite idea prove, after all, uneconomic.

Conversion to Planetary Society

Much of what Dr. Vajk urges is reminiscent of Antoine de Saint-Exupéry's dictum: "As for the future, our task is not to forecast it, but to enable it." We are admonished to concentrate less on "negative predicaments," and to bring as much skepticism to bear on allegations of "problems" as on advertisements of "solutions." The sentiment is consistent with Denis Gabor's *Inventing the Future* and, more generally, with the mood of the French Enlightment and its belief in the inevitability of progress.

The author is at his best when he provides the observation, "Because of the extent to which our behavior reflects our assumptions and our modes of thinking, a future of high quality of life depends on high quality visions of the future." It is, of course, quite true that human beings could accomplish far more if they were willing to cooperate instead of compete; the idea of turning the Sahara into a garden is not impossible technically — but the political obstacles are enormous! It is sobering to reflect that, thus far, the only really successful effort to halt the advance of the Sahara was the extensive series of public works (aqueducts, treebelts, irrigated agriculture) carried out and defended for centuries by the famous Augusta Roman Legion. A society based upon knowledge and cooperation, as Dr. Vajk recommends, is surely desirable, but one must wonder how the cooperation can remain constitutional rather than coercive. The social cement hoped for by the author is an agreed general pursuit of excellence. In a sense, this book is theological; at least it combines a series of (unexceptionable) moral precepts with an invi-

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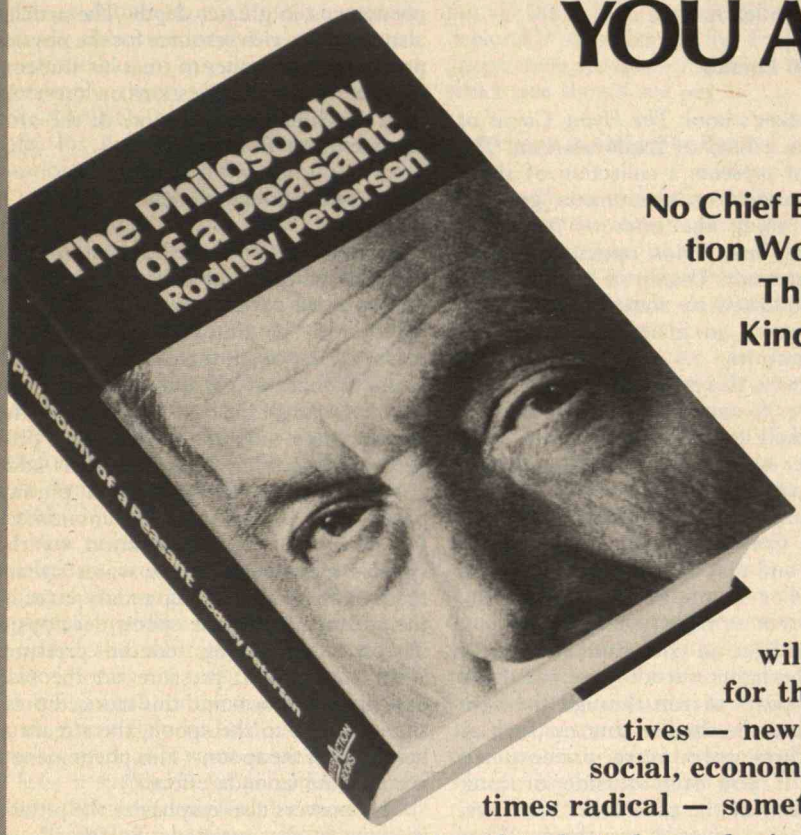

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INTERACTION BOOKS

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tation to large-scale engineering "out there" — and it is the engineering, not the theology, which will require some exacting cost-benefit accountancy.

This book is more important than its relaxed style may indicate: we are being asked, in fact, to underwrite some of the most expensive hardware in the history of technology. That such a seductive polemical tract originated near the San Andreas Fault and close to the home base of the Institute for the Future may give pause to some conservative Easterners. But with the Space Shuttle tuning up for its first flight, and with Governor Brown impatiently waiting in the wings, the Congress of the United States will doubtless increase the allocations of research and development funds for what may become a major new version of the American dream in the third millenium. Peter Vajk's strong credentials as a scientist, and his passionate plea for a new perspective on planetary society, will strike responsive chords even in the East. Perhaps the Club of Rome will now wish to examine "celestial dynamics"! It is too early to scoff: let us not allow a serious proposed change of *milieu* to be bogged down by methodological minutiae.

Frank Davidson is chairman of the System Dynamics Steering Commmittee at M.I.T.'s Sloan School of Management, where he teaches innovative subjects such as the uses of failure. One of the first proponents of a tunnel spanning the English Channel, he is co-editor of Macro-Engineering and the Infrastructure of Tomorrow. □

A Physics Appetizer

The Flying Circus of Physics WITH ANSWERS
Jearl Walker
New York: John Wiley & Sons, 1977, 295 pp.; $9.95

Reviewed by Uri Haber-Schaim

For years physics was an exciting way of life for relatively few professional physicists, a required college course for chemists and engineers, and an alien topic for most of humanity. Even otherwise well-educated persons had no interest in the subject and felt no need to be informed about it. Then came the escalation of our involvement in Indo-China, and with it a retreat from science and technology. Physicists began to realize that something had to be done to bridge the gap between them and the public at large.

To make the public aware of the fundamental ideas and methodology of physics, one first needs to demonstrate how fascinating and intriguing physics can be. To put it differently, to be interested in answers one had first to realize that there are questions, and questions emerge from observing and experimenting. This is the main idea behind Frank Oppenheimer's Exploratorium in San Francisco, which differs from other science museums (at least it did when I was there the last time) in that it lets the visitor see and wonder, manipulate, and think. There are no written explanations; no vocabulary to learn.

Hands on Physics

Jearl Walker's book *The Flying Circus of Physics* is a kind of Exploratorium. The book first presents a collection of about 600 situations or phenomena grouped roughly along the lines of acoustics, mechanics, heat, fluids, optics, electricity, and magnetism. Usually a brief description is followed by some questions and sometimes by an invitation to estimate some quantities.

Obviously, this is not a book one reads from cover to cover in one or two sittings. One is likely to browse through it; or, if the reader has noticed an intriguing phenomenon while driving a car or flying in an airplane, he or she would check the Table of Contents or the Index, and be likely to find that the phenomenon is discussed. For example: "When driving through rain at night you will find long streaks of light on your front windshield due to the lights outside your car. Each streak appears to run through the light source, and the smaller sources (such as streetlights) give more pronounced streaks. If you step outside or look through any of the car's other windows, however, you won't see them. What causes these streaks? Are they as prevalent when it's not raining?"

The browser may notice an illustration of a spoon in which its convex side sticks to a stream of water. Walker coaches the reader: "If you hold a light spoon round side upward in a stream of water as shown the spoon seems to be glued to the stream. You can move your fingers several inches away, putting the spoon at a considerable angle, and the spoon will still refuse to leave the stream. The falling water should, by all rights, push the spoon away, not attract it. What causes this?" If he is skeptical and curious, he may go to the kitchen and try it for himself.

Occasionally the author challenges the reader with questions that require a fair amount of knowledge, and even more insight: "On the earth why aren't there any mountains significantly higher than Mt. Everest, say, ten times higher? (Nix Olympica on Mars is over twice as high as Mt. Everest.) If there is some limit to mountain heights, then what determines it, and approximately what is the limit?"

This particular question was answered in an elementary form as recently as 1969 by M.I.T.'s Victor Weisskopf. Among the 600 phenomena there is something of interest for everyone: from a person with no knowledge of physics all the way to the teacher of physics or researcher.

An enormous bibliography follows this text, listing monographs and original articles that deal with the individual phenomena in more detail. References to the bibliography are found at the end of each "problem." Just compiling this bibliography alone is a major service to anybody who wishes to study the mentioned phenomena in greater depth. The articles also provide a rich resource for the physics professor who wishes to treat his students to some "relevant" questions on a test! As with any bibliography, some of the articles are better than others.

Sidestepping Enlightenment

The earlier version of the book ended with the bibliography. The newer version contains a third part: answers. I found this addition to be unfortunate for several reasons. First of all, there *are* no short answers to most of the questions raised in the main part of the book. As a result, the answer often amounts to throwing professional jargon at the reader. This adds nothing for the reader with a physics background but swamps the uninitiated. For example, the explanation to the spoon's attachment to the water stream reads as follows: "The boundary layer of the stream next to the spoon develops a narrow eddy having reduced pressure. With atmospheric pressure on the side opposite the spoon and this reduced pressure adjacent to the spoon, the stream is held against the spoon. (This phenomenon is called the Coanda effect.)"

The answers also emphasize the pitfalls in some of the questions. Specifically, it would be better if many of the "why" and "what causes . . ." questions would have been replaced by "What do you predict will happen if . . .?"

Many of the answers would benefit from a drawing, but no drawings or diagrams are included. Finally, only some of the questions raised by each situation are answered, and usually the less intriguing ones, making the reading of the answers anticlimactic. Readers who feel this way will just stop reading the answers, and then no harm is done. However, it would be a pity, at least in most cases, if the readers get excited by the phenomena and the questions they raise, and then feel satisfied with the answers provided. For such readers the book will substitute vocabulary for understanding. Had the author thought of the Exploratorium, he would have left out the answers.

To sum up, the book is not "a new way to learn, to appreciate basic science . . ." as the publisher claims on the back cover. But, it may be a good way to get people to *want* to learn and appreciate basic science, and in that lies its major contribution.

Uri Haber-Schaim is director of the Institute for Curriculum Development in Science and Mathematics at Boston University. □

Boulding

(Continued from p. 8)

an A; 80 to 89, B; 70 to 79, C; 60 to 69, D; and below 60, F, on the traditional scale before grade inflation. Taken literally, this puts an enormous premium on the student doing everything that is asked, at least with mediocrity. The student who writes an examination with four questions and is so enraptured with one of them that he spends half of his time on it and answers only three questions cannot get more than a C if the grader follows a rigid scale, for even 100 per cent on three questions and zero on the fourth will give an average of only 75 per cent. The main thing that students learn from such an examination system is not to be carried away with enthusiasm, that it is better to do everything in a medicore way than to do one thing superbly. Perhaps in view of the overwhelming importance of mediocrity in social life this is good training, but it often does discriminate against the exceptional student, and it is not surprising, therefore, that many of the greatest and most creative human beings flunk out of school.

I have never really been able to find a satisfactory answer to this question of adding up or weighting grade scores. The deplorable inability of ordinal numbers to be added and subtracted, multiplied and divided, forces one into cardinal numbers. Yet the overall problem of grading remains obstinately ordinal. Any cardinal number grade is in some sense a fraud, or at least a surrogate for something much more subtle and complex. But then I hold that cardinal numbers are a fraud anyway and that they are largely figments of the human imagination and do not exist in the real world.

Averaging

I have sometimes tried to get over this problem of the dimensionality, especially the one-dimensionality, of grades in a world of many dimensions by giving check marks, with plusses and minuses after them to indicate the quality of a paper or exercise. This has the great advantage that one can give a check mark with both a plus and a minus after it to indicate a piece of work which has some good points and some bad points. This would be lost in a simple averaging. Averaging in general indeed is a great destroyer of reality, a witch's caldron in which many important distinctions melt. In spite of being clever about this, however, I am then faced at the end of the semester with the record book in which there are long lines of checks, with plusses and minuses and occasional double plusses and double minuses and I have to add these up. Cardinality triumphs along with averaging, and I come out with a cardinal number, usually I must confess somewhere in the 80s, and admit defeat.

I cannot resist making a hideous confession. I once told a student who came to me and complained about his grade, "Well, this is an unjust world and education is intended to prepare you for it." Everybody knows that there are inevitable random factors in grading. This is no excuse for not trying to reduce them. Even if part of the educational process is learning to put up with the things that have to be put up with, in a famous example of a deplorable structure in the English language, there are also some things "up with which one should not put."

Objections to Objective Exams

The search for reducing randomness has inspired the movement, partly inspired by laziness, but partly also I think by a genuine desire for objectivity, to turn to the so-called objective examinations, with double or multiple choices. These are a valuable investment for the teacher as long as they don't get out into the fraternities, for they are much easier to grade than essay examinations and indeed can be graded by a hireling subordinate. In this case, however, the search for objectivity has led to some catastrophic educational results. If our students cannot read or write today, the blame must be laid squarely on the objective examination, for this is what they prepare for. That which is not rewarded is not done, at least according to economic theory. If a student is not rewarded for writing clear and legible statements, there is very little incentive to do so in the formal education system. Another problem with the objective examination is that it tends to divorce the testing process from the learning process, and this also is a catastrophe. We learn only by the recognition of failure and feedback from it, so that testing and learning should be intimately related. This is why I have always protested the institution of a final examination. Testing, it seems to me, should always take place before the end of a course and be part of the learning process, and all examinations should be returned to, and discussed with, the student.

The awful truth about grading, however, is that it is an information economizer. Its great, and perhaps only, virtue is that it is cheap. It saves trouble because it saves us from information overload in the appraisal of individuals. In saving trouble, however, it also commits injustice. Perhaps, however, its saving grace is that in the most crucial decisions of life it is not taken seriously. We rarely ask to see the grade sheets of the person we invite to be our spouse. I doubt if formal education can abandon grades, simply because they are its only physical product. Like all other products of the mind, however, grades are evidence and not truth, and if they are treated in this way they may not do much harm and could conceivably be a little useful. □

Cowen

(Continued from p. 11)

it. As he urged at the conference, this could be the beginning of a global data bank of historical climate information. A universal coding and standards for data quality and verification would have to be developed. Once in hand, it would be an immensely valuable resource for researchers.

Does Climate Affect History?

However, it is doubtful that historians would be as enthusiastic about it as would the climatologists. If historians step carefully in using old documents, most of them refuse to tread at all into the field of trying to interpret human history in terms of climate. They consider the notion absurdly simplistic. As noted by J.L. Anderson of La Trobe University in Bundoora, Victoria, Australia, historians regard the notion as "a delightful eccentricity, at best, and, at worst, a graveyard of reputations." "Although climate may be inferred from its effects, the process is not reversible. Historical effects cannot be inferred from the climate," he said. Too many other factors are at work. He added that "if there had been no climatic change, the history of Europe would have been much the same."

Historians at the conference commented that this attitude kept many of their colleagues from attending because they thought it would be a waste of time. That was unfortunate. Historians who think this way are missing the point. What is needed is fresh insight into the impact of climate change on people, insight that is relevant to what Dr. Lamb calls the "anxious problems of human welfare and the stability of the international economy" raised by the prospect of climate changes today. Whether or not historical climatic research would help refine European history is of secondary importance. As Dr. Lamb pointed out, it can be fascinating to pursue the subject for its academic interest. But there are hard-pressed planners and decision makers who have to make important decisions in which climate is a factor, and it is up to the experts to try to give them all the help they can, however intractable the research needed may seem to be.

Perhaps this is why the challenge of this new field of historic climatology has passed most historians by to be taken up instead by such scientists as geographer R.W. Kates and his colleagues at Clark University in Worcester, Mass. "The question," Dr. Kates remarked during the conference, "is what are we going to do with this knowledge when we get it? It has to help us today." His group currently is studying three case histories, all in dry, marginal lands — the U.S. great plains settlement, the African Sahel, and the Tigris-Euphrates area of the Mideast from

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"Fast Bucks" or Slow Wealth in the New China Trade?

Countless American executives have bought air tickets to Peking since 1975 when they heard Chou En-Lai call for a massive investment in new technology. But the reality is more complex, the patina a little less shiny, than some may have assumed. The modern China trade turns out to present navigational problems which are no less tricky than those faced by the clipper ship captains in the Straits of Magellan a century ago.

Here are some of the problems — many too little understood, according to experts at a symposium on business with the People's Republic of China arranged by the M.I.T. Alumni Center of New York late last spring:

☐ *Changing priorities*. The fourth of China's "modernizations" — the one calling for massive investments in technology — seems to have new emphasis on labor-intensive and light, consumer-goods industries at the expense of high-technology and heavy industry. To Kenneth P. Morse, president of Chase Pacific Trade Advisors, this looks like a "clear decision" by China's leaders to reduce the demand for foreign capital, to respond to China's serious problems with unemployment, and to increase the nation's supply of consumer goods. To Professor Lucian Pye, M.I.T.'s principal "China watcher" in the Political Science Department, the new posture may represent less change than fine-tuning. He tends to think of the original four "modernizations" as a broad-brush "trial-balloon . . . to be taken more figuratively than literally."

Be that as it may, this tempering will diminsh Chinese demand for what American corporations can do best. But not to worry, said Frank Press, President Carter's science adviser: "We expect the basic outline of the program to remain intact," he told the M.I.T. meeting.

☐ *The missing infrastructure*. China provides a vivid lesson in the problems a developing nation must solve in joining the modern world: it is a nation of 800 million people with no national highways, no national electric grid, only 3 million telephones (that's one for every 300 people), and no more than 200 individual telex lines. Even today 85 per cent of the new locomotives being built in China are steam engines designed to burn coal.

☐ *The problem of cost*. The Chinese persistently underestimate the cost of new technology. Dr. Press explained: for at least five years before Chou's four "modernizations," China deliberately isolated herself from technological progress. The Chinese know they missed a lot of new technology, but they fail to understand that today's prices are new, too.

☐ *Foreign competition*. Like U.S. entrepreneurs, Japanese and Western Europeans are actively peddling their technology in China, whose buyers are astute bargainers. In this competition the U.S. has two serious disadvantages: 1. There is no participation by the Export-Import Bank to reduce interest rates on loans for American exports. Without it, the U.S. is "monumentally out of the ball park" (the phrase of John E. Corrigan, senior vice president of the First National Bank of Chicago) compared with most other industrial nations. Obtaining Export-Import Bank support for China trade presents knotty political problems (*see below*). 2. Most other industrial nations came in first. While policy forbade all U.S. contacts with P.R.C. for nearly 25 years, foreign firms were free to establish footholds in the mainland market.

☐ *Ideological differences*. Capitalist and socialist systems don't work together easily: they make value judgments on the basis of wholly different criteria. The Chinese, for example, have no sense of how the marketplace can set priorities and how monetary incentives can affect quality and efficiency in the workplace. On the other hand, David K. Janet, who worked in China for 15 months as project manager for Pullman-Kellogg Division of Kellogg Corp., recalls "spectacular examples" of the industry and effectiveness of Chinese workmen — the same traits of "intensive, dedicated labor" which must have been devoted to building the Great Wall 1,000 years ago.

☐ *Return on investment*. Perhaps because of these ideological differences, the Chinese are determined that their marriage of convenience with Western technology be far from permanent. For example, when Chinese talk about joint ventures, which are a most promising mechanism for transferring technology, they insist on agreements of no longer than ten years' duration.

Trading Information, Fireworks, and Food

But the sold-out Peking hotels and the constant procession of Chinese delegations through American universities and industries are not exactly casual tourist travel. "Modernization" is a serious issue for China; it represents an important opportunity for Western technology, and the Chinese are as anxious to achieve it as we are to help them.

After arranging for countless Chinese delegations to visit the U.S. — and hosting many at M.I.T. — Walther A. Rosenblith, provost of M.I.T. who is a member of the U.S. Committee on Scholarly Communications with the People's Republic of China, is convinced that the intellectual commerce between the U.S. and China a decade hence will make today's "scientific tourism" look primitive indeed. For example, some 500 technical seminars are being held in China in 1979.

Furthermore, a lively trade between the U.S. and China is already in place, the Chinese sending to us such low-technology products as silk, antiques, bristles, feathers, fireworks, and simple cotton goods. The value of U.S. exports to China is overwhelmingly in agricultural products; but the Chinese are also buying computers and other electronic equipment, diesel engines, railroad equipment, and a host of high-technology products and processes. Mr. Morse thinks some of the "best opportunities" are for high-technology, spin-off companies typical of Boston's Route 128 and California's "silicon valley."

As the Chinese confront the realities of the fourth "modernization," they suddenly sense the difficulty and importance of decisionmaking and such tools as analysis, modelling, and data processing — in short, all the things that in the industrial West have come to mean "management." So now there's an "absolute priority" on the hardware and software of decisionmaking, said Nicholas H. Ludlow, director of research at the National Council for U.S.-China Trade.

The Importance of Being Friendly

Will the Chinese turn our technology against us in some future economic or even military confrontation? Dr. Press was at pains to point out that U.S. military technology cannot by law be sent to China; and he admitted that the Chinese could expedite the flow of all kinds of new technology "by being more forthcoming on the end uses they have in mind."

Cultivating the Oriental Virtues

What about the nitty-gritty of the Sino-U.S. trade? For example, to make deals with the Chinese, must you speak Chinese? No, said Mr. Janet, he's never experienced a language problem. Many

Chinese are multilingual, and it's routine that contracts be negotiated and written in English.

Mr. Morse's approach may be a bit more sophisticated. His sales proposals, he said, are always addressed in Chinese and mailed in China — never addressed in English and mailed in the U.S.

That may be a subtle recognition of the wisdom of Julian M. Sobin, chairman of Sobin Chemicals, Inc.: "The Chinese don't like to do business with people who don't like them." Mr. Sobin clearly likes the Chinese and their culture — a student and collector of Chinese art, and aficionado of the Peking lifestyle; he has made nearly 30 trips to China since Americans were first permitted to enter in this decade, and he is now the first American purchaser of Chinese crude oil.

Other symposium speakers joined Mr. Sobin in emphasizing three virtues to be pursued in negotiating with the Chinese; be flexible, be patient, and — above all — be quiet. ("If your transactions become public," said Mr. Morse, "you invite every agency in the bureaucracy to take a pot shot at them.")

"Everybody seems to be out to make a fast buck on China," said Mr. Sobin. "And the Chinese don't like it."

Seductive Symmetries

Mr. Morse — he's perhaps the only American who's been privileged to have an office instead of a hotel room from which to watch it all happen in Peking — says the future of Sino-U.S. trade is "very good indeed for selected firms and industries." It was "unthinkable a year ago that we would now have so many cooperative agreements in place, so many interrelationships operating. . . . a healthy and astonishing rate of development in the U.S.-China relationship," he said.

One reason is the symmetry of U.S. and Chinese economic and political interests. The shadow of the Soviet Union hangs over us both, and the U.S.-China partnership lightens that cloud for both its partners. Two contradictory consequences:

☐ The U.S. has resolved to treat the U.S.S.R. and China even-handedly — no "special favors" to one or the other. But this policy makes "most-favored-nation" treatment (and Export-Import Bank support) a sticky problem for China because the Soviets cannot qualify for that status.

☐ For their part, the Chinese welcome a visible involvement with the U.S. This is partly because of its effect on the balance

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of world political power; but Dr. Press suggests that the Chinese in fact "especially admire" American technology and "would prefer to buy from us."

Professor Pye was more cautious: while admitting all these reasons for optimism, he suggests the dangerous possibility that the developing U.S.-China relationship may in fact be fueled by a "seductive combination of Chinese pride and Western greed." He warned his audience against "exaggerated expectations"; he fears that what he regards as the "legitimate enthusiasm" of some U.S. entrepreneurs who have successfully negotiated with China is being extrapolated into overexpectations and oversimplifications of what is necessarily a complex, changing relationship with a nation whose problems of modernization and perhaps even survival are "staggering."

To general amusement, Mr. Corrigan, who heads the China group of the First National Bank of Chicago, replied by characterizing all political scientists as "the crabgrass in the lawn of life." He finds the Chinese worthy partners — their credit standing good, their long-range financial management competent. From the new Sino-U.S. trade, he says, will come modest new wealth for Americans who are content to be quiet, patient, and competent negotiators. ☐

Forthcoming Conferences

☐ October 4-6: **"Nuclear Power: Challenge for Journalists,"** an objective briefing on nuclear power issues for newspaper, radio, and television reporters. Room 9-150, M.I.T. Further information from Michael W. Golay, Department of Nuclear Engineering, M.I.T., Cambridge, MA. 02139.

☐ October 16-17: **"Technology, Innovation, and Industrial Development,"** a comprehensive review of factors that affect technological innovation in the U.S. Kresge Auditorium, M.I.T. Further information from J. Herbert Hollomon, Center for Policy Alternatives, M.I.T., Cambridge, MA. 02139.

☐ October 27: **"Technology: a Future Necessity?"** a survey of current and future trends and needs. Kulas Auditorium of John Carroll University, University Heights (Cleveland), Ohio. Further information from Sheldon Thorpe, M.I.T. Club of Cleveland, care of Western Reserve Associates, 3100 Mayfield Road, Cleveland, OH 44118. ☐

Research in Progress

☐ Increasing use of composite materials in aircraft and automobiles has sparked a new study of the role of coupling agents in their production, sponsored jointly by the Air Force Office of Scientific Research and the Army Reserve Office. Principal investigators are Professors Chong Sook Paik Sung of M.I.T. and Nak-Ho Sung of Tufts University.

☐ Seeking improved microprocessors for automobiles, the Department of Transportation is sponsor of basic research on computer-based controls to increase fuel efficiency and reduce exhaust emissions from internal combustion engines. The work in the M.I.T. Energy Laboratory is part of a $2.8 million D.O.T. program on problem areas in transportation at 28 universities in 19 states.

☐ Methods of making submicrometer structures (less than 1,000 angstroms wide) are the focus of a new laboratory under Henry I. Smith and John Melngaillis in the M.I.T. Center for Materials Science and Engineering. Professor Smith foresees a key role for these minute structures in future integrated electronics and information storage devices.

☐ Thirteen universities in New England and New York — with M.I.T. as the lead institution — have joined in the University Coal Research Consortium of the Northeast. Its goal: a comprehensive research, educational, and industrial program promoting clean use of coal and fostering development of U.S. coal resources. Jean F. Louis, associate director of the M.I.T. Energy Laboratory, is consortium director. ☐

Computer Logic for Advertising Budgets

Your new industrial solvent is developed, patented, and ready for production. But how shall you spread the glad tidings in the marketplace?

Ask ADVISOR, a new computer-based system for helping managers set and allocate advertising and marketing budgets — a product of Professor Gary L. Lilien and his associates in the Sloan School of Management.

To use ADVISOR, you will have to answer a set of 19 questions; these answers are the inputs. From the computer will then come some norms for the kind of product and stage of development you've described. Compare these norms with the figures you are using or budgeting and you have "new guidelines against which current industrial marketing decisionmaking can be checked," says Professor Lilien.

Pursue the industrial solvent example: the advertising-to-sales ratio — industrial norm — for this product, ADVISOR says, is about 2.4 per cent; that's more than three times the median level of all products in ADVISOR. Industrial solvents are "growth" products, and the market is mostly made up of many small customers; for both these reasons, ADVISOR says, advertising budgets have to be "significantly above the median" ratio. If your budget isn't there, it probably should be.

Does ADVISOR work? An early test result shows that "the farther spending varies (either more or less) from the ADVISOR norm, the lower is product profitability," says Professor Lilien. ADVISOR is "an important first step," he thinks, "in developing quantitative tools to support the industrial marketing budget-setting process." □

U.C.S. vs. Nuclear War

The Union of Concerned Scientists, whose wrath has been felt by every advocate of nuclear power and nuclear reactors, is turning its firepower on another side of the nuclear issue — the strategic weapons race.

Between them, the U.S. and the U.S.S.R. now have 20,000 megatons of deliverable strategic nuclear warheads, enough for each to obliterate the other some 100 times over, says Henry Kendall, Professor of Physics at M.I.T. who is a founding member and leading strategist of U.C.S. But Americans have no understanding of the consequences of a nuclear war between the superpowers, says Professor Kendall, and so he is turning the full persuasive force of the organization to the task of stopping the deployment of new nuclear weapons, reducing nuclear inventories, and cutting defense spending.

"Containing the arms race is one of mankind's most urgent needs," he said at an M.I.T. meeting early this year. □

Cowen

(Continued from p. 83)

ancient to modern times. They are trying to see how diverse people adapt and respond to climatic stress, in these cases, primarily periodic drought.

Whatever the effects of climate on people and their societies, they are likely to be subtle and to show up most clearly in marginal areas. Experts at the conference agreed that, whether it was the demise of the Norse colony in Greenland during the Little Ice Age or the perennial ennui of farming in Maine, people trying to make a living in marginal lands are the most susceptible to climatic change. What gave a serious undertone to all such discussion was the uneasy feeling that, in some sense, mankind, through overpopulation, environmental degradation, and unwise agriculture may be making Earth as a whole a marginal land. "We are better off than our forefathers in being able to help one another with short-term aid," Dr. Lamb said, "but I gravely doubt we are better off in dealing with long-term effects of climatic change." Seen in this perspective, research into climate and history is not so much a new academic field as it is part of a search for survival. □

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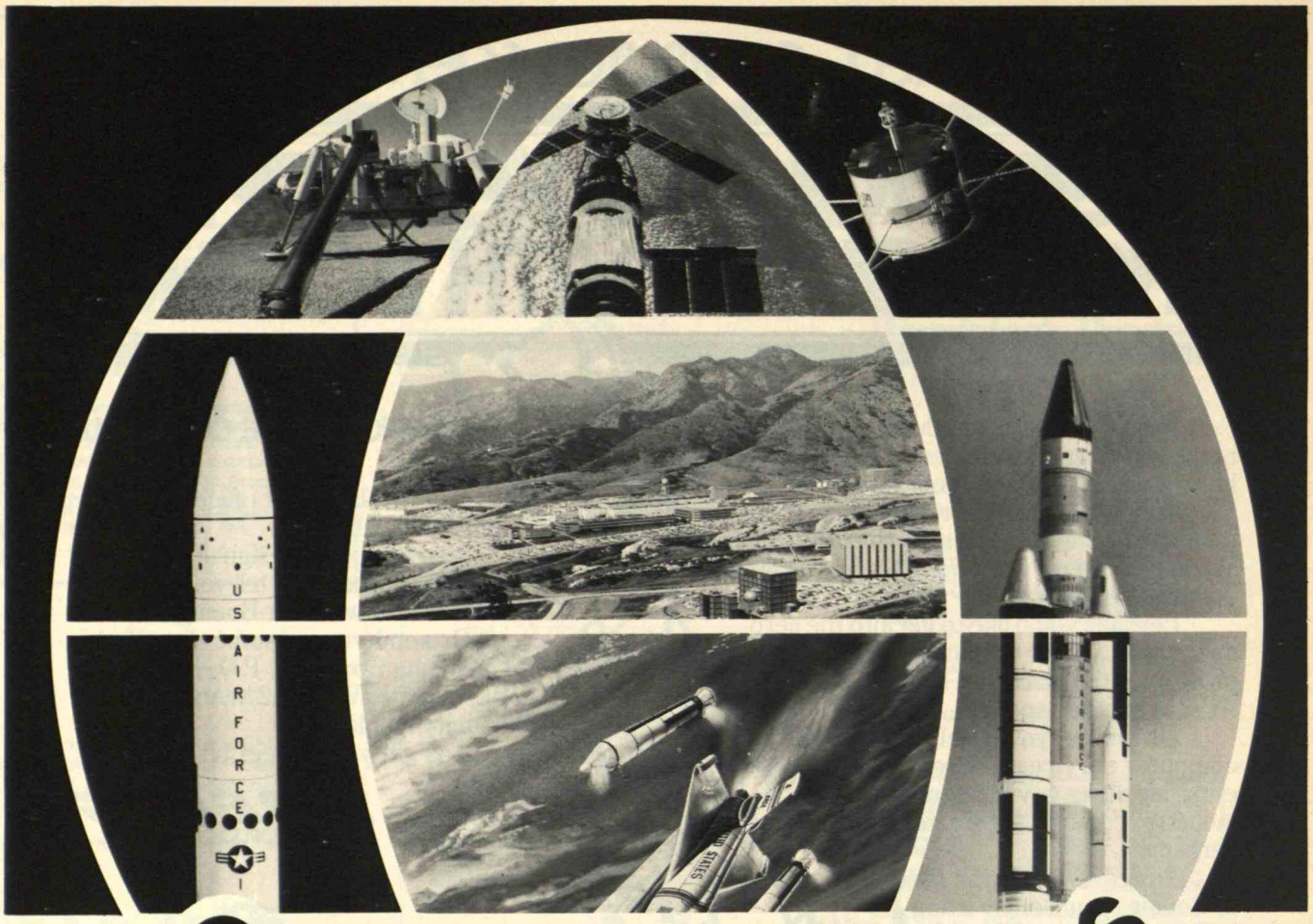

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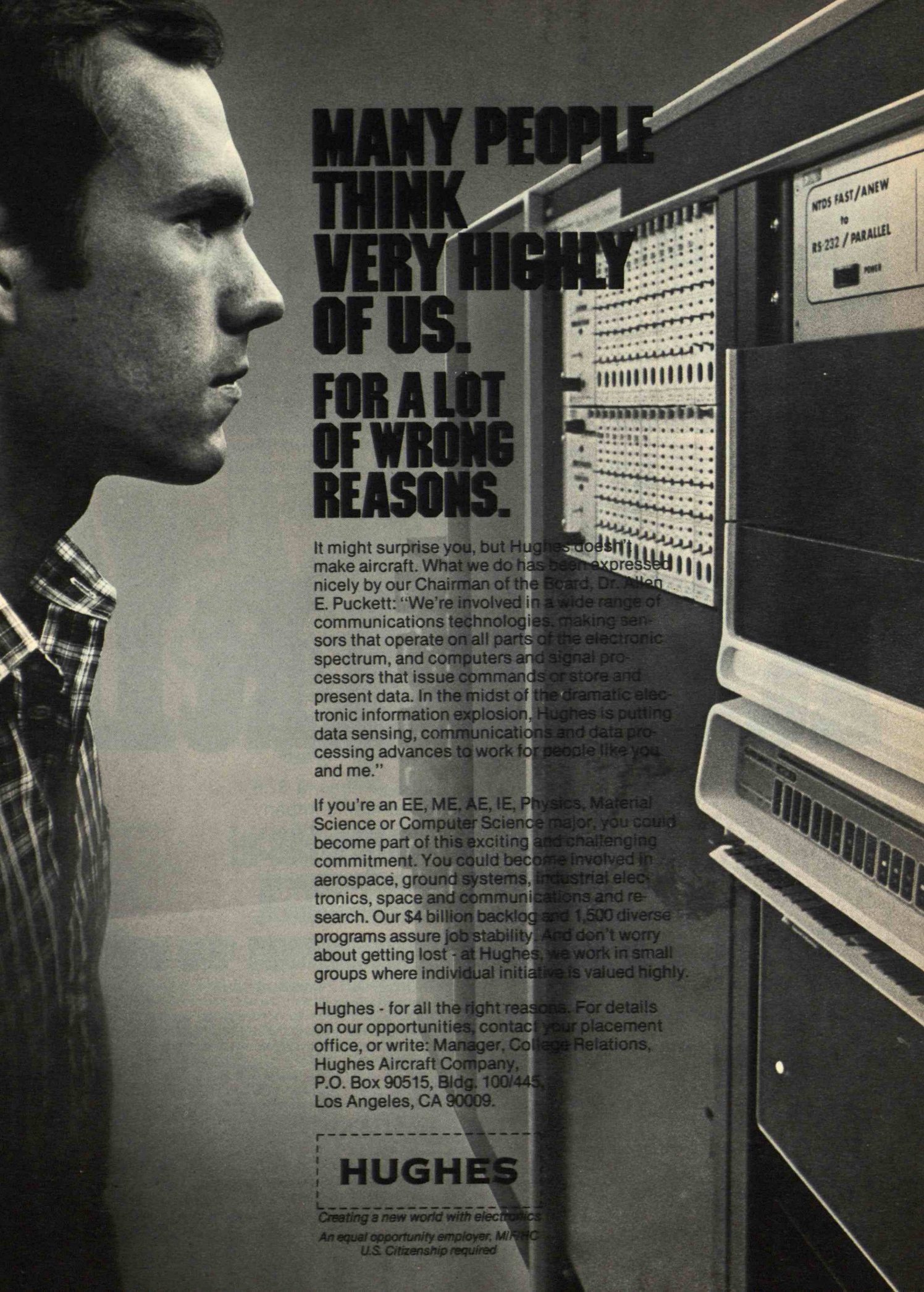

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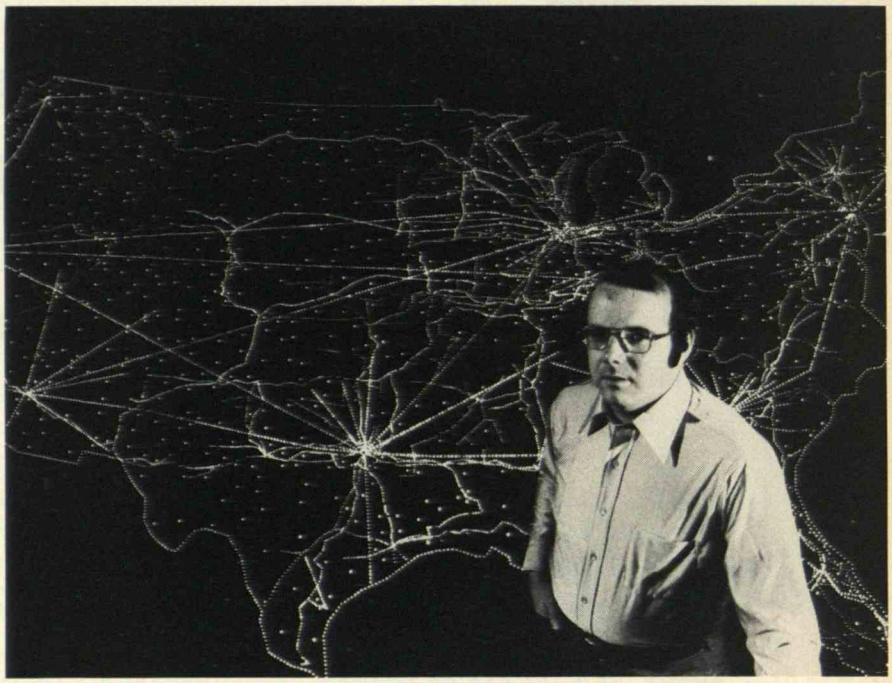
For several years the Bell System used its computerized Network Operations Trouble Information System (NOTIS) to try to pinpoint those causes by analyzing trouble reports from all over the country. NOTIS was good. But Bell System managers wanted it to be better, more precise in identifying possible trouble spots. And they wanted the data in compact, easy-to-use form.

We assigned a new employee, Don Hartman, to improve NOTIS. Don came to us with a B.S. from the University of Texas and an M.S. and Ph.D. from Massachusetts Institute of Technology. He and his associates developed a second-generation system (NOTIS II) that does the job superbly.

For the new system, Don developed a mathematical model of the telecommunications network, including 28,000 local and long-distance switching offices and nearly a half-million circuit groups. Don also designed the system software and served as a consultant to the team of Bell System programmers assigned to the project.



Each day trouble reports from the entire country are sent to the NOTIS II center in Atlanta. Overnight, the system analyzes the reports, processes them through the network model, and discerns trouble "patterns" which help identify potentially faulty equipment. By 8 a.m. the next day, via data links, analysts at phone company service centers receive information on troubles traceable to circuits or switching equipment in their territories. Result: Better equipment maintenance. And better service.

With NOTIS II up and running, Don has moved on to other projects. Today he's a supervisor with broad responsibilities for planning the telecommunications network of the future.

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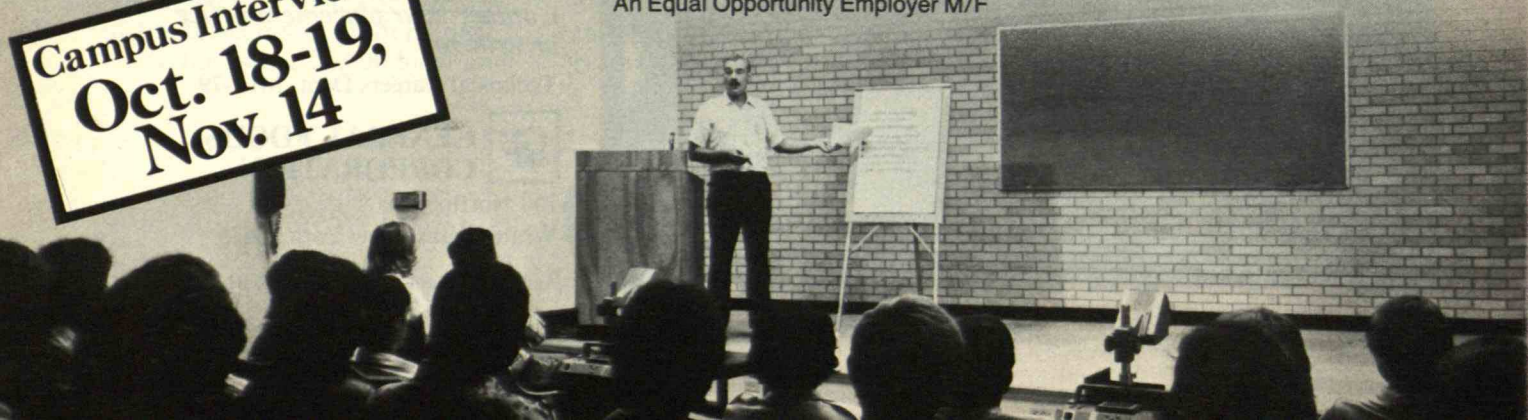

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